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(*Recognosce notum, ignotum inspice*)

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RECENT LICHEN LITERATURE

By A. LORRAIN SMITH, F.L.S.

Introduction

One of our most distinguished British lichenologists, Thomas Hebden, died at Keighley on January 3rd, 1931, at the age of 82. He was one of the company of Yorkshire naturalists who did so much to foster the field study of Cryptogamic Botany. For many years he was in touch, not only with British, but also with foreign lichenologists—the late Dr Nylander and others—and his wide knowledge was placed freely and generously at the service of all. He left his herbarium to the museum of Keighley, Yorkshire.

We also record with great regret the passing of Karl Schulz-Korth in his 25th year. His special service to botany was in the study of plant geography and systematy. Latterly he had turned his attention to lichens, especially in the Mark Brandenburg, and in 1928 published his first contribution. A list of his papers will be found in the "literature." He was a keen worker carrying out to the full his own ideals as quoted by Mattfield (1931): "Dass ohne das Herz, auch dem Gebiete der Geisterarbeit, nichts grosses vollbracht werden kann." Lichenology has suffered serious loss by his early death. Another notable worker, E. Bachmann, passed away recently. He began his research on lichens late in life, and attacked mainly the problems of unusual development. His papers have appeared in various journals during recent years and include many studies of deformations due to invading fungi or to untoward conditions.

The last two years have seen the issue of several works of great moment to lichen students: among them the eagerly awaited completion of Alexander Zahlbruckner's *Catalogus Lichenum* in seven volumes with a record of 13,885 species; it has been promptly followed by a necessary *Supplementum* of 612 pages, with a very considerable addition of genera and species. The two lichen volumes of Migula's *Kryptogamen-Flora von Deutschland* have been completed. The descriptions are clear and full, the coloured plates are numerous and beautifully produced. Three additions, of interest to lichenologists, have been made to "Rabenhorst's *Kryptogamen-Flora*": Karl Keissler (1930) has given us a comprehensive work on "Flechtenparasiten." It includes fungi that grow by preference on lichens, all of them ranked as parasites. He evidently does not accept the symbiotic character of many. Later have appeared "Cladoniaceae" by Sandstede (1931) and "Stereocaulon and Umbilicariaceae" by Frey (1932). The authors' names vouch for the very high standard of the works.

Handel-Mazzetti's *Symbolae Sinicae*, Teil III, "Lichenes," has been issued by A. Zahlbruckner, an indispensable work of consultation for students of eastern lichens. It includes all previously recorded species in the territory, with many new species and forms and also a few genera new to science.

Not less important are the accounts of special groups contributed by Bernt Lynge, whose area of research includes Nova Zembla, Franz Josef Land and Greenland—a welcome record of the difficult lichen flora of these northern lands. Special groups and genera have also been dealt with, as, for instance, Magnusson's monograph of the genus *Ionaspis* and his study of the species grouped round *Lecanora subfusca*. Fran Kusan (1932) has given a similar examination of Cladoniae belonging to the *Sylvatica* group, with her views on essential specific characters.

The lichen plant

Gonidia. In a paper by Elfving (1931), with many pages of illustrations, there is a renewed attempt to affirm the old theory of the hyphal origin of gonidia. Elfving repeats his account of the gradual appearance of green colouring matter in the hypha finally resulting in the formation of an independent green cell. The nature of the green-coloured globules was explained by Zukal* in 1884, and there is no reason to doubt the accuracy of that explanation. Elfving accepts all the subsequent developments of the green cells: their increase by autospores and also the possibility of independent growth and multiplication outside the lichen plant. He argues from inference rather than from direct observation and has not attempted to provide proof by cultures—the only satisfying method. If we have to accept some Chlorophyceae as of lichen or hyphal origin, why not all? Workers of acknowledged eminence have noted the arrival of green cells from the open to form alliance with the protothallus. Elfving may, perhaps, claim these cells as returning to their first allegiance! Tobler (1932) has carefully reviewed Elfving's work: he considers that Elfving's statements are lacking in precision, and in convincing proof as to the nature of those green cells, given off, according to him, by the hyphae. The spectroscope should have been used to test the presence or absence of chlorophyll in the green-coloured hyphae. As bearing on the subject may be cited the study of development in the thallus of *Pertusaria* by Darbishire (1932); he observed, not only the arrival of free algae from the open, but also their incorporation by the protothallus. Bachmann also (1932) noted the arrival and absorption of free algae on the podetia of Cladoniae.

There has been considerable attention paid to the algal cells. Chodat (1930) repeats the conclusions he had arrived at that each

* See "Lichens," p. 103.

lichen species has its own gonidial species, and, further, he asserts that no lichen gonidium that he has studied corresponds to the green algae so common on trees, etc.: they differ in cellular structure and in cultural behaviour. The alga in the open he determines as *Pleurococcus Naegelii*—the lichen species as *P. monas* or *P. Chodati*, though he allows that other species may also become symbionts. An interesting paper by Harold Bold (1930) throws considerable light on the subject in his study of *Chlorococcum infusionum*, the alga to which Puymaly gave the name *Trebouxia*. Bold describes the life history as shown by cultures—the form of the cells and the parietal chromatophores, already demonstrated by Paulson as a character of the gonidium. He has described the reproduction of the algal cells as a process of cleavage into aplanospores and zoospores, the latter intimately associated with a sufficiency of moisture, which is exactly paralleled by the constant formation of aplanospores in the lichen plant, with the further development of zoospores in the more moist conditions of artificial cultures.

The alga *Coccomyxa* had been recognised by Chodat (1913) as the gonidium of *Solorina* spp.; Jaag (1931) has verified this statement; he has also found Coccomyxae in *Peltigera aphthosa*, in *P. venosa* and in *Icmadophila ericetorum*. These gonidia are somewhat polymorphic, being affected by the culture media. As gonidia of *Solorina* they were able to assimilate carbonic acid gas; *Cladonia* gonidia under the same conditions showed poor assimilation. M. and Mme Moreau (1932) observed that the gonidium of *Dermatocarpon* divided into four daughter cells, thus proving affinity with Chodat's genus *Coccobotrys*.

As regards blue-green algae, Grumann (1931) records the presence of both *Nostoc* and *Scytonema* under the apothecia of *Solorina spongiosa*. Kaule in his work on the cephalodia of *Stereocaulon* explained the origin of the blue-green gonidia as due to the alighting of adventitious blue-green algae on the podetium and their subsequent incorporation by the hyphae; he claims a similar origin for the green gonidia of the phyllocladia.

Frey (1932) has published a critical and suggestive résumé of recent works on gonidia, all of which tend to prove the errors in Elfving's deductions. Frey considers as difficulties in the way of culturing gonidia the somewhat changed condition of these algae as specialised gonidia, also the chance that an alga collected outside the lichen plant may be either an escaped gonidium or a free-living organism. The attempt to induce symbiosis between the two organisms is thus beset with difficulties. He himself recommends that for the study of development a soredium or a small scrap of the selected lichen should form the basis of the culture. He suggests also that a natural substratum, such as stone or bark, washed with a nutrient solution containing some suitable acid, might give good results. He makes the

final request that a work should be provided setting forth the results already obtained and also giving reasoned views on the many different algae that serve as gonidia.

Jessie Jones (1930) in her investigation of Cyanophyceae found an increase of nitrogen in the cultures: its presence was traced to nitrogen-fixing bacteria such as *Azotobacter*, *Bacillus radicicola*, etc. The healthy growth of the algae and of the lichens associated with them in desert places is thus explained.

Parasymbiosis. Werner (1928–9) has made a study of the relation of lichen host and associated fungal growths included under the term parasymbiosis—that is, semi-parasitic fungi that live on the lichen thallus, not by preying on the lichen, but by associating with the gonidia. There is no evidence, he finds, that these parasymbionts ever become independent lichens. Nannfeldt (1932) has also discussed this subject and he has concluded that these "epiphytes" are more nearly related to lichen- than to fungus-genera. Kurt Gerber (1931) found also that the accepted fungal parasites in the more advanced stages frequently penetrated the thallus and associated with the gonidia as parasymbionts. Such a fungus, *Pseudophacidium* n.sp., he found on an *Usnea*: perithecia and pycnidia were formed, the hyphae—penetrating the host—increased in vigour and size but created no disturbance of the gonidia. Keissler (1930) has included all parasymbionts under parasitic species.

Morphology

Structure. The formation of the symbiotic lichen thallus has always challenged attention, but the natural slow growth has been a formidable obstacle to continuous observation. We are all the more indebted to Darbishire (1931) for his account of development in *Pertusaria communis* (*P. pertusa*), a common lichen that spreads widely over the trunks of old trees. The mature lichen shows an advancing margin of hyphae—the pro- or protothallus—which extends the area of the plant on all sides. These hyphae grow out centrifugally from the underside of the thallus attaching it to the bark, and penetrating cracks and crevices as they advance; they grow actively and secrete the matrix in which later they themselves become embedded. Further growth observed includes a tissue layer, gonidial layer and upper cortex. Single cells or groups of *Cystococcus* cells were frequently noted on the recently differentiated parts, thus continually adding to the gonidial layer. Finally Darbishire concludes that the formation of medulla, gonidial layer and cortex present well-defined structural differentiations, though they are not morphologically fixed as are the epidermis, cortex and stele in higher plants.

Bachmann (1931), before his lamented death, published an interesting study of development of leprose species usually placed

under the genera *Lepra* or *Lepraria*. The hyphae, in the forms he describes (including *Lecidea uliginosa*), generally predominated, creeping at first over the substratum and living on plant remains, the association with algae taking place later, either with small groups (goniocysts) or with solitary gonidia; finally a sparse gonidial layer becomes recognisable. The hyphae may also penetrate masses of blue-green algae which they encounter. This type of leprose thallus must not be confounded with the sorediate thallus, also frequently an inhabitant of damp situations.

R. G. Werner in two papers—on the germination of spores (1930) and on the lichen synthesis (1931)—also traces the development of the thallus. He followed the course of the symbiotic alliance not only in cultures, but in the natural habitat on the bark of trees or in the soil (1931); the direction of growth was according to the lichen character—crustaceous, foliose or fruticose. He asserts that the fungus determines the form of development, though it is the requirement of algal nutrition that dominates the form. M. and Mme Moreau (1930) concluded, from their study of *Stereocaulon*, that the lichen is an "algo-cecidium," a gall condition of fungus on alga.

Sandstede (1931), in his recently published "Cladoniae," points out the extreme variability of the primary thallus and podetia, both being strongly influenced by external conditions, hence the many species, varieties and forms that have been given status in lichen classification. These though of doubtful stability serve, he considers, in calling attention to the variable growth. Sawyer (1931), in her study of *Cladonia ochrochlora*, found that the first appearance of the podetial squamule was a protuberance from a crack which gradually developed as a squamule. Wainio long ago drew attention to the labile character of the genus, though, as Sandstede also points out, while some species vary enormously, in others, such as *Cladonia caespiticia* and *C. delicata*, there is little tendency to variation.

In discussing the many varieties of *Cladonia* species Sandstede stresses the influence of substratum, altitude and climate in determining the form of the squamules and podetia. In addition there is wind, dryness and moisture, not only influencing the form, but tending to create a similarity between different species. Light and shade also modify the colour as was pointed out by Cuthbert (1930) in his study of the changes induced in *Xanthoria parietina*.

Eduard Frey (1933), in his "Umbilicariaceae," has given a similar contribution: he describes the general thalline development, the organs of attachment—the umbilicus and the rhizinae—with the origin of polyphylly in some of the species. The dark coloration, almost black in exposed sunny situations, is due to a "Nekralgewebe" (a dark tissue) formed of a protecting layer of dead hyphae which in time scale from the surface without damage to the underlying tissues.

A peculiar arrangement of tissues occurred in a new *Porina* species described by Riehmer (1931). There are several distinct layers in the thallus: above a series of dead gonidial and hyphal cells, below that a true gonidial layer, then lower a latticed medulla of dark empty cells with intruding gonidial groups, and below these a gonidial layer bordering on a hyponecral base. The lichen grew on stone. These studies indicate the variety of tissue as well as of form produced by the symbiotic alliance of fungus and alga.

Soralia and Isidia. Bachmann issued an important paper (1932) dealing with these external features of many lichens. He found that both appeared most readily when the growth of gonidia and hyphae were at their highest activity in the podetia of the Cladoniae examined; soralia were formed when green gonidia alighted—they were surrounded by the hyphae and became an integral part of the podetium. Cyanophyceae were rejected. The soralia took various forms—flat, angular or blackberry-like, and were rather powdery on the surface. Sawyer (1931), in her careful paper on *Cladonia ochrochlora*, considers that soredia on the surface of the podetium originate from "foreign gonidia," the hyphae evidently stimulated by their arrival to more vigorous growth. Magnusson (1932) describes snow-white soralia on *Evernia prunastri*; Erichsen (1932) found orange soralia on *Physcia ocellata* n.sp. in northern Germany.

Bachmann (1931) found isidia on *Verrucaria horizontalis*, a calcareous lichen; they arose as irregular growths, the hyphal cells forming a plectenchyma with numerous gonidia included. These adventitious bodies were easily separable and of service in propagation. The bud-like structures of Umbilicariae (Frey, 1933) may be cited as isidia: they also serve as disseminating agents. Gyelnik (1931) makes the presence of isidia on *Peltigera* a strong systematic character.

Cephalodia. These structures are mostly outgrowths on the surface of the lichen thallus that differ from the parent plant in their algal constituent which is blue-green—*Nostoc*, *Scytonema*, etc. Different views have been held as to their relation to the original thallus. Kaule (1931) considers them as gall formations, specially indicating those formed on the podetia of *Stereocaulon*, and the dark-coloured prominent growths on *Lobaria laciniata*. In the former, the foreign gonidium arrives from the open and is annexed by the podetial hyphae; in *Lobaria* the cephalodia take origin within the thallus from intruded blue-green algae; these are surrounded by hyphae, and the intensive growth emerges as a dense, dark-coloured, branching structure. These peculiar cephalodia have not been found on North American specimens, and Tobler (1932) has suggested that their absence may be due to unfavourable surrounding conditions; he states further that the form of these cephalodia varies according to the changing growth of their gonidia, or of the normal gonidia of the

Lobaria thallus, and that on the whole their presence is somewhat hurtful. M. and Mme Moreau, in describing the podetial stalks of *Stereocaulon*, note the arrival of blue-green and bright green algae. The lichen hyphae, excited to new growth, surround the algae and produce a cortical layer resulting in the formation of cephalodia and phyllocladia—the former with blue-green algae, the latter with bright green.

Darbishire (1932) has contributed an account of the origin and development of the well-known cephalodia on *Peltigera aphthosa*: the normal gonidia are bright green (*Dactylococcus*), those of the cephalodium, *Nostoc* cells. The normal thallus bears hairs on the surface which are excited to growth by the alighting *Nostoc* and, as stated by Kaule (1931), they arise near the margin. The foreign algae are surrounded, the first hairs forming the stalk of the cephalodium; as the new structure expands, the thallus below suffers somewhat from overshadowing. Goebel (1928) had stated that hyphae from the new structure travelled down as attaching strands; Darbishire does not support that statement.

Reproduction

Ascogonium. M. and Mme Moreau (1932) have published an account of the reproductive process in *Stereocaulon coralloides* and in *Dermatocarpon.* In the former they found that the fertile bodies originated at or near the tip of the podetium as minute clumps of uninucleate ascogonial hyphae united by a central protoplasmic strand. These hyphae become binucleate and the asci take origin as croziers at the end of a short chain of cells. Trichogynes are often present but soon degenerate. In *Dermatocarpon* there was an ascogonium of coiled uninucleate cells with abundant protoplasm. Several ascogonia might mingle their coils and from each a trichogyne emerges, which, as in *Stereocaulon*, degenerated before emerging. Further development was to binucleate cells and a formation of crozier and ascus. A somewhat similar type of ascogonial development was observed by Mlle Moruzi (1932) in *Lecanora*, *Placodium* and *Squamaria.* She traced the formation of spermogonia and spermatia which, however, took no part in fertilisation. *Dermatocarpon* is a pyrenolichen with perithecia and the Moreaus find in development a common ancestry for discolichens and pyrenolichens; in any case they consider the ancestral Pyrenomycetes to be a heterogeneous group.

Apothecia and spores. In his study of Umbilicariaceae Frey has traced the gyrose apothecial lines in *Gyrophora* to the thickening of the walls of certain paraphyses, which become cellular and brown, thus giving rise to furrows. The furrows may also represent the united growth of one or more apothecia. Frey has not regarded the form of the spores as of generic importance though he retains as sections the

different types—simple and colourless or dark and muriform. Choisy (1931) attributed the gyrose lines to a broken succession of the fertile tissue which coincides with Frey's description.

R. G. Werner (1930) has given a comparative study of spore germinations—the time of year and the subsequent development of the hyphae. *Cladonia* spores divided in the culture before producing hyphae. *Xanthoria* and *Caloplaca* (*Placodium*) germinated in early spring from each end of the septate spore. In *Umbilicaria* one to three germinating tubes were produced from the poles. In *Anaptychia* a round bud-like germinating body was formed from which issued a secondary normal mycelium.

There is no question of a functional trichogyne in these studies. Other writers are chary of ascribing sexual significance to the pycnidia. Sandstede in the introduction to his "Cladoniae" quotes Sattler's statement (*Hedwigia*, 1914) that there is present within the genus a transition from the sexual to the parthenogenetic development of spores. He himself invariably makes use of the terms "conidangia" and "conidia." Frey in "Umbilicariaceae" insists that "pycnidia" and "spermogonia" cannot be used as interchangeable terms when they do not have the same function in all groups. He allows that they may very probably serve as sexual bodies in several Cladoniae, but it is well to use the designation pycnidium when the sexual character is not proven. The non-sexual "pycnidia" or "conidangia" are used by Sandstede and Frey in all the genera described.

A note of some interest is contributed by S. G. Jones (1930) on the significance of the "terminal" of the ascogonial coil which, he found, emerges and acts as a respiratory hypha in apothecial development. The observation was made on an examination of the fungus causing "Leaf-spot disease" in clover.

Tobler (1932) has emphasised the importance of reproduction by thalline particles in the Cladoniae—more especially in the section *Cladina*. The closely packed swards with dense branching tend to break up with any outside disturbance, and the fragments spread easily giving rise to new plants.

Physiology

Lichen acids. In a comprehensive examination of the bio-chemistry of micro-organisms under the direction of Prof. Raistrick, new acids were discovered as the metabolic products of such fungi as *Penicillium*, *Aspergillus*, etc., when grown on a medium of glucose and various salts. An observation was made (p. 10) as to the general resemblance between some of the specific products of these fungi and the so-called lichen acids. Thus the product from *Penicillium spiculisporum* ($C_{17}H_{28}O_5$) is similar both in empirical formula and general chemical

properties to oxyroccellic acid ($C_{17}H_{32}O_5$) isolated by Hesse in 1898 from different Roccellae, and also to proto-α-lichesterinic acid ($C_{18}H_{30}O_5$) which occurs in the lichen *Cetraria islandica*. This resemblance supports the view that it is the fungal symbionts constituting the lichen which are responsible for the formation of the lichen acids. This view of the fungal origin of the acid is the one accepted by lichenologists, with the reservation that the alga in combination is obligatory at some stage of growth to the formation of these acids.

In two recent papers (1931) on *Chiodecton sanguineum*, a tropical lichen, Prof. Tobler (1931) has paid special attention to the occurrence of the brightly coloured acid "chiodectin." The lichen is of a primitive type—loosely growing fungal hyphae mixed with sparsely scattered algal cells or cell groups of *Trentepohlia* or of Protococcoideae. In the central parts of the thallus, where the algae are more or less abundant, the acid coloration—a bright purple-red—is often well marked, but it is even more distinct and constant at the circumference, where algae are few or had mostly disappeared. In some specimens there were noted isidial tufts of projecting hyphae free from algae and coated with the red crystals, but these also originated from a base of protococcoid gonidia. No fructification has been found, and Tobler considers that we have here a recent lichenoid combination. It might with equal insistence be argued that *Chiodecton sanguineum*, judging from the intensity of acid production, is a very old plant of simple or degenerate structure. A similar structure occurs in *Crocynia*, though in that genus fructification occurs in some species. The British species *C. lanuginosa* has never been found with fruit formation, and many species placed in *Crocynia* are probably undeveloped stages of other lichens.

Tobler (1931) found oxalate crystals abundantly produced along with the red colouring crystals at the periphery of *Chiodecton sanguineum*. He suggests that, as a source of carbonic acid gas, they may serve as nourishment for the alga. Schütt (1931) records acids of the fat series in *Cladonia tenuis*, *C. polyactyla* and *C. degenerans*.

In his review of lichen culture studies, Frey has suggested that growth might be hastened by the addition to the culture of an acid known to be a constituent of the lichen tested; it might thus be possible to ascertain if the acid were specific or a feature of the habitat. In connection with the presence of acids in certain lichen species Lynge (1932) has recorded that the mild tasting *Cladonia mitis* was the only member of the *Sylvatica* group brought back by the Godthaab Expedition from Greenland, and I have found the bitter acid lacking in *Cladonia rangiferina* (K + yellow) from the Mauritius. Sandstede, in his study of Cladoniae, records the presence of hitherto unsuspected acids such as usnin acid in *Cladonia mitis*, and he also

indicates the value of acids as a guide in many instances to the determination of species.

Cell contents. Cengia-Sambo (1931) has published a résumé of her conclusions as to the nature of the carbohydrates in the lichen plant. (1) In the blue-green gonidia the first observable product is glucose, while in the bright green it is an oil. (2) In the blue-green lichens, there is present a nitrogenous bacterium, *Azotobacter* sp. (3) In these blue-green forms she recognises a "pole-symbiosis," and if cephalodia also occur there is a "tetra-symbiosis." "Bi-symbiosis" is confined to the bright green series. Her discovery of oil in the thallus of the latter is supported by the work of Buscaglione and Scaramella (1931) on chlorophyll lipoids, droplets of oily matter which take a blue coloration with iodine. Cengia-Sambo reiterates that the carbohydrates of lichens are glycogen, oil and glucose; she failed to find any evidence of the presence of starch grains.

With reference to the presence of nitrogenous bacteria Jessie Jones (1930), in her cultural investigation of Cyanophyceae, noted an increase of nitrogen which she traced to the presence of nitrogen-forming bacteria, such as *Azotobacter* sp., *Bacillus radicicola*, that fix nitrogen in the alga as do the bacteria in the root nodules of Leguminosae. The healthy growth of blue-green algae and associated lichens in desert regions is thus explained.

Water. In a comprehensive paper on lichens Goebel (1928) has contended that the source of their water supply was mainly air-moisture or rain, and the reception was through air hyphae from which air is expelled as water enters. He also insisted that water is not present in intercellular spaces. Some lichens such as Umbilicariae depend on rain for their water supply: Lobariae growing on sheltered tree trunks are supplied by water that trickles down the bark. Goebel further has discussed the effect of these different conditions on assimilation, evaporation and transpiration, and also on carbohydrates. The reaction between the symbionts, he concludes, is so finely adjusted that any idea of parasitism is untenable.

In a study of lichens on Plymouth coasts G. Naylor (1930) observed that *Lichina pygmaea* grew more luxuriantly on rocks subjected to breaking waves: she has suggested that the air bubbles in the foam may be a favourable influence.

Bionomics

Rate of growth. Voigtländer-Tetzner (1932) gives an interesting report on lichen growth: the territory examined was an old pinewood (spruce) which had been cut down and again replanted. In two and a half years the young trees were about 30 cm. high, there was then no trace of lichen growth, but after five and a half years there was already a flourishing *Cladonia* ground flora. The young pines by that

time were over 2 m. high, rather sparsely set, so leaving room for the entry of light; there was no trace of *Calluna*. Sixteen species were determined, with numerous varieties, the nearest colony of *Cladonia* being 10 km. distant. The writer suggests, however, that there might have been present, in the soil, spores or lichen particles, etc., that could have started the new lichen colony; he noted in an extremely crowded position a dead *Cladonia* which seemed to foreshadow the extinction of lichens as the shade became more dense. Other lichens such as *Parmelia physodes* and *Cornicularia aculeata* had also arrived on the young wood.

Brinkman (1931) has suggested that certain lichen growths may give an indication as to the value of land for planting: thus some Cladoniae are constantly found on poor soil; other lichens on logs, etc., prove the occupation at some previous time by trees that grow on good soil; he found, however, that other influences came into play such as habitat, altitude and orientation. Paasio (1931), in discussing moor lichens, notes their abundance on *Calluna* moors and that, after the ground is cleared, they take a large share in renewing vegetation. *Biatora granulosa*, a quick grower, is one of the first to spread over naked ground. The peopling of waste land is assigned by Tobler (1932) to Cladoniae that cover large expanses of waste spaces such as sand-dunes. Their method of increase has already been recorded*.

Lichens as pests. A good deal has been written about the damage caused by lichens on trees. Liou Tchen-Ngo, in his "epiphytic vegetation of conifers," touches on this question. He found that trees in an unhealthy or backward condition were more covered with lichens than are healthy trees; but though lichens are not parasitic they tend to retard assimilation and respiration, thus accelerating the death of already enfeebled trees. R. G. Werner (1928) also remarks on another phase of the harmful action of lichens. Their hyphae or rhizinae may attach themselves to various plants (mosses, etc.), grow over and gradually smother them. Von Tubeuf (1932) also discusses this question of injury by lichen growth. He finds that, though in no sense parasitic, the lichens cause disturbance by harbouring insects, and also, by retaining water, they may occasion swellings in the bark. He recommends spraying with Bordeaux mixture, a complete antidote.

Gall formations. Bachmann (1930) has published many studies of deformations on lichens due to various causes. Thus he has described pycnidia-like protuberances on *Cladonia mitis* which was sent to him from Spitzbergen and Oldenburg as merely adventitious growths induced by extremely cold conditions producing an irregular development and a brown coloration. Other pseudo-galls on *Parmelia*

* p. 100.

physodes (1930) he considered due to fungal infection. The first result was a marked development of gonidia in the lichen. These fungal hyphae had spread into the gonidial zone with ascus and spore formation. No gall hyphae reached the medulla. In the second type of gall examined, also on *Parmelia physodes*, there was formed a somewhat similar fructification which he termed a "protapothecium." In a further study (*tom. cit.*) he described pseudo-galls on *Peltigera* which were not due to fungi or insects; the gonidia had increased owing to disturbance, and the new tissues differed from the usual type of gall formations. Sandstede (1931) has called attention to the frequency with which Cladoniae are parasitised by fungi. He refers also to the animal pests in the herbarium: they work havoc on *Cladonia* plants, especially those that are "mild tasting" such as *Cladonia glauca* and *C. nemoxyna*, though bitter plants are by no means immune.

Systematy

Classification. The collection and classification of plants is of essential importance. Lichens are not easy plants either to collect or determine, and our debt to those who have undertaken this branch of lichenology is unquestioned. In some instances, however, there seems to be too great a readiness to split up well-established species into varieties and forms, or even into new species based on characters that are induced by conditions of growth. In a recently published edition of Bishop Berkeley's *Commonplace Book* we read the lament (p. 86, n. 714): "Words have ruin'd and overrun all the Sciences—Law, Chymistry, Astrology, etc." There is a danger to-day that "words" may overrun and ruin the taxonomic science of Lichenology. Magnusson (1932), commenting on the lichen studies of Gyelnik, writes in a footnote (p. 36): "...What lichenology needs is not a name of each preserved specimen...but a survey of the variability of the species founded if possible on studies in nature." A fuller expression of his views on the subject will be found in a recent paper (1932) on "Lichen systematy." He deprecates again the too frequent publication of species on inadequate characters. It is impossible to give here any full account of his criticisms and suggestions.

P. A. Genty (1932), in his record of lichens found on the granite protrusions (îlots) near Dijon, has advised the necessity of restricting rather than of multiplying specific, varietal or form designations due to possibly accidental growths. "On oublie trop," he writes, "que le nom d'une plante n'est en somme qu'un moyen de la désigner, et de la connaître, et que plus elle en aura, moins elle sera bien connue, puisque de la multiplicité des noms naîtra la confusion." Lichens, in many instances, are plants of more or less unstable growth, so care should be taken to recognise certain leading characteristics alone

as specific. Varieties, as agreed, also show differences from the species which are uninfluenced by outward conditions: the divergences, however, should be sufficiently distinctive to justify later writers raising them to the higher rank.

Elenkin (1929), in an essay on classification, recognises two systems of procedure: (1) the "genealogical" based on divergence of character, and (2) the "combinatif" on their convergence. The former is the more frequent and is that on which Darwin based his *Origin of Species*. He considers that leading species such as *Cladonia rangiferina* and *Lecanora subfusca* rank as Linneons, their associated minor species as Jordanons. This view may be compared with Magnusson's recent study of *Lecanora subfusca* (1932), in which the many varieties are established as true species. Incidentally, we note that Magnusson has replaced *L. subfusca* by *L. subfuscata* Magn., an alteration that transgresses the agreed rules of nomenclature. In his discussion of the "*subfusca*" group he makes distinctive use of minute microscopic characters such as the occurrence and position of crystals and granules within the thallus or on the epithecium. His study does not lessen the labour of the systematist.

Nannfeldt (1932), in his paper on the "Systematy of Discomycetes," classifies these under two great groups: those symbiotic with algae as "Leanorales," those not so associated as "Non-Lichenoses." He holds that the more highly developed lichen families and genera form phylogenetic units and are not to be traced to special fungi, although discolichens are akin to Discomycetes, pyrenolichens to Pyrenomycetes. Nannfeldt, basing his conclusions on the anatomy of the fruit bodies, holds that the open apothecium is the more primitive form as evidenced in the fungus genera *Ascodesmis*, *Pyronema*, etc. He notes as differences in the two groups that of the long-lived apothecia of lichens, and that the thalline hyphae are cartilaginous (a rare feature in fungi), also that they contain isolichenin in their membranes as do the tips of the asci. In addition there is the development of acids*, a sign of antiquity.

Signora Eva Mameli-Calvino (1930) has given an interesting account of the much-discussed *Chlorocyphella* recently relegated by Keissler to Fungi. She has demonstrated that the plant—an epiphytic lichen—is associated with an alga, *Cystococcus* sp.; the fructification is that of a "Deuteromycete": the spores (*Scolecosporae*) are borne on filiform, unicellular pseudobasidia, in an open cup-like receptacle. She proposes a new class, "Deuterolichenes," with—so far—one genus and two species, *Chlorocyphella aeruginascens* and *C. subtropica*. Keissler (1933) quotes the above account of the plants but without comment. Both species occur in South America, the latter also in Cuba. From Schade (1932) we have a study of the two dark-coloured

* See under "Lichen acids."

species of *Coenogonium*, *C. nigrum* and *Racodium rupestre*, both of which frequently grow together, and the mass was named *Byssus nigra*. Schade claims to have studied the earliest specimen and determined it as a *Coenogonium*, to which he gives the specific name *nigrum*. He has rejected *Cladophora* as the alga of *Racodium rupestre*, but does not suggest any other gonidium.

Fran Kusan (1932) has reviewed the classification of the *Cladina* section of *Cladonia*: she has restored the well-known species *C. sylvatica* to its comprehensive position, re-establishing *C. impexa*, *C. mitis* and *C. tenuis* as varieties, their morphological characters not being marked enough to justify specific status; she has also criticised the varieties and forms of *Parmelia conspersa* which had been described by Gyelnik. She judges that allowance has not been made for changes in edaphic or geographical conditions. Many of us cordially welcome her criticisms.

C. A. Robbins and S. F. Blake have given us an interesting contribution dealing with the Cladoniae of Western America, with a comprehensive and descriptive key to the species, thirty-six in all.

Räsänen (1932) has had the good fortune to find a fruiting specimen of *Thamnolia vermicularis*, a widespread and common lichen in northern lands. This lichen has therefore been removed from *Lichenes imperfecti* and tentatively placed near to *Roccella*, the fruit formation being somewhat similar; the spores are muriform and colourless and measure *ca.* $26 \times 10\,\mu$. In British lichens the most important contributions are those of Dr Watson (1930–2). It is practically agreed that we accept Zahlbruckner's nomenclature, but Dr Watson has given generic rank to the *Parmelia* subgenus *Hypogymnia*, and also to *Biatora* regarded as a section of *Lecidea*. He also reintroduces *Platysma* as a genus. It is questionable if these changes are of value.

Distribution. Under this heading the papers dealing with the collection and determination of lichens from many lands are dealt with. Lichens abound in most countries, and have everywhere attracted the attention of serious students. In Scandinavia they are specially conspicuous. Bernt Lynge, Magnusson, Sten Ahlner, Malme and Vrang are still working on distribution in these northern lands, many of the lichens being circumpolar. One of the most important papers by Lynge (1932) is a revision of the genus *Rhizocarpon* as it occurs in the far north: it is better represented in the Eastern Arctic than in the Western, only six circumpolar species are known. Gunnar Nilsson (Degelius) has issued notes on various species as well as a record of Lapland lichens. Magnusson contributes a valuable monograph of *Ionaspis*. So far as known the species are found in high altitudes or in northern lands. Veli Räsänen has furnished a list of Esthonian lichens, with descriptive notes on distribution and growth conditions. Russia, from north to south, a mighty

field, has not been neglected. Boris Keller, Nikolsky, Rassadina, Savicz, Oxner and others have added to the store of knowledge. In the British Isles, a record is published of the lichens collected at the Spring and Autumn Forays of our Society. H. H. Knight or R. Paulson has usually taken charge of the lists. Watson (1930–2) for the county of Somerset has recorded species new to Britain and has also found a number of Larbalestier species previously known only from West Ireland, and Mayfield has published Suffolk lichens. The county is lowland and lacking in rocks, saxicolous forms were therefore scarce.

In Central Europe we find many able workers. C. F. E. Erichsen in his *Beiträge* (1932) adds species old and new to the German flora. Further south, Szatala in Bulgaria, Hillman in Bavaria, Servit in Jugo-Slavia, Hilitzer in Bohemia and others have done valiant service. Motyka has also issued descriptions of some Silesian lichens. We all eagerly await his promised publication on the genus *Usnea*. In Switzerland, Meylan and Frey have contributed new lists, and in France Bouly de Lesdain, Choisy, Genty, M. and Mme Moreau have issued special studies. In Italy Ginzberger in the Abruzzi and Sbarbaro in Liguria have been collecting and recording species. From America we have to record the Cladoniae of the Gaspé Peninsula (Allen, 1930), with notes on the wide distribution of some species. Evans (1930) has published a study of Cladoniae in Connecticut, with keys and notes on field conditions. Joyce Hedrick gives an account of lichens in Oklahoma, Lucy Raup the lichens from Lake Athabasca. Cengia-Sambo (1931) describes collections made by missionaries in Patagonia. Collections have been made in Mexico also by missionaries, and named by Bouly de Lesdain (1929), mostly rock species from the high mountains (up to 3000 m.): everywhere there were dense growths. Felippone (1929–30) gives us records of the lichen flora of Uruguay, and Răsănen has given interesting records from the extreme south, finding lichens that grow also in New Zealand but not in Australia, a confirmation of previous land connection. He points out also the great likeness between Arctic and Antarctic species.

From the Far East we have as already noted the *Symbolae Sinicae* of A. Zahlbruckner. He has also published lists of lichens from Central Asia, and from Formosa. Prof. Asahina is gradually forming a "Lichen Flora" for Japan. Prof. Chaudhuri, of Lahore, with the assistance of his pupil Chopra, is dealing with the lichens of northern India. An interesting observation by Sten Ahlner (1931) presents the view that lichens have in many cases travelled from the East. He cites *Evernia divaricata*, *Alectoria sarmentosa*, *Usnea longissima* and others, as eastern species that have entered Europe possibly with the pine trees. Africa has not been neglected in these worldwide con-

tributions. R. G. Werner (1930) has devoted his attention to the Moroccan flora. He found that lichens of temperate regions formed the majority; those of least importance, in numbers, were tropical or subtropical; the endemic flora was about 10 per cent. of the whole. Eva Mameli-Calvino (1930) has broken new ground in Abyssinia and Eritrea by publishing some forty species and varieties from these lands, collected by several explorers: all are European species. O. A. Hoeg (1931) took notes of the lichens at Victoria Falls: he found nothing of special interest nor any trace of a supposed great forest. Van der Byl (1931) has published a first instalment of a lichen flora for South Africa and Rhodesia.

Ecology

Lichens vary ecologically: some few grow more or less well in very different situations, others—the large majority—are restricted to special conditions of substrata, exposure, etc. Ecology is thus distribution from a special standpoint. A feature of this science we find is the great liberty claimed by students to invent new terms. Thus in a paper by Mattick (1932) we read that the lichens best adapted to narrow limits of *p*H soils are to be ranked under "stenion," those with a wider limit "euryon." Acid soil also exerts its influence, hence azidophil lichens. *Nephroma parile* is "azidophilstenion," *Peltigera aphthosa* is "azidophileuryon." Mattick concludes that most lichens demand a strongly acid substratum, fewer an alkaline. The azidophilous families include Cladoniaceae, Parmeliaceae and Gyrophoraceae; the basidiophilous (alkaline) Collemaceae and Verrucariaceae.

Maritime associations. Du Rietz leads the way with the marine lichens of East Sweden. The associations nearest the shore are described as the Hygrohalophyten, such as Lichinae and certain Verrucariae. Further back grow *Caloplaca marina*—and *Lecanora actophila*—associations, etc. Coprophilous associations abound where the sea birds roost.

De Virville (1931–2) has described much the same type of sea-coast association in northern France. Des Abbayes has also described similar association for the coasts of Brittany. Always it is Lichinae and special Verrucariae that flourish near the sea. Bernt Lynge and Scholander (1932) noted the absence of nitrophilous lichens on the sea-cliffs of North East Greenland—there were no nesting birds on these cliffs.

Inland associations. Lucy Raup (1930) examined the associations on the shores of Lake Athabasca. On the stony and sandy shores *Verrucaria* was dominant down to and below water-level; a little higher the steep granite cliffs were inhabited by *Dermatocarpon miniatum*, Physciae and Lecanorae. On the uplands grew *Parmelia*

saxatilis and *Gyrophora Muhlenbergii*, Cladoniae and Cetrariae were abundant on the ground, Parmeliae and Everniae on the trees.

C. F. E. Erichsen (1931) gives an interesting account of *Staurothele catalepta* var. *fluviatilis*. The species, a mountain lichen, the variety growing near the mouth of the Elbe above and below Hamburg, and very abundant, except where the waters were contaminated from the town, as aerial species are similarly destroyed by air pollution. The lichen grew best where there was alternation of wet and dry conditions. He has also described the conditions of lichen growth in the lower course of the Trave River near the sea. He indicates the characteristics of the various localities, as affecting the development of the different species.

Boris Keller has described the lichen flora of the Volga river valley, mostly soil or rock species. Some are endemic, others such as *Psora decipiens* with a wide distribution. The presence of salt in the soil gave rise to a halophytic flora in which he includes *Teloschistes brevior* var. *halophila*. Erratic lichens were a special feature of the region—these are lichens that become detached from their support without losing vitality: they become inured to a drifting condition whereas others do not survive the loss of support. *Parmelia vagans* and *Lecanora* (*Aspicilia*) *esculenta*, the supposed manna lichen, are typical erratics.

Another interesting paper is by Cengia-Sambo (1932). She has made an intensive study of lichens in a high valley of the Adige, with special attention to tributary valleys. She dwells particularly on the influence of climate and altitude in determining lichen growth. Other valuable ecological records are by Degelius (1931) in Sweden (Province Ångermanland). He has related the lichen growth to ecological conditions—the geological formation, the pine woods, climate, rainfall and snow duration. Oskar Klement (1931) has made a study on similar lines in the Erzgebirge: he gives rainfall, geological formations, epiphytic and soil associations, the latter mostly Cladoniae.

Corticolous associations. Liou Tchen-Ngo (1929) has studied the lichen population of conifers, chiefly of *Pinus sylvestris*. After the clearance of ground growth the first colonisers on the trees are crustaceous species, Lecanorae, etc. This phase is of short duration and is followed by foliaceous species, mainly *Parmelia physodes*, and later by fruticose forms such as Usneae, *Evernia prunastri* and *Alectoria jubata*. The upper side of the branches and the upper reaches of the trees are the most favourable to lichen growth. Haugsjå (1930) has given an account of tree lichens in the neighbourhood of Oslo—in the parks and open places. They are mainly found on the older trees, *Lecanora Hageni* being the most common. A careful record of all the data is given with reference to this lichen growth—the distance from the centre of the town, the influence of light, etc. Most of the lichens had dwarfed thalli and grew at the base of the trees; there was also

an increase of isidia and soredia. The author considers that these leprose forms are true species of the genus *Lepra*. Finally he traces three growth zones: (1) a "desert zone" in the centre of the town, (2) a "struggle zone" nearer open country, which merges into (3) the "normal zone" though the boundaries are indistinct.

We have also a study of town influence by Servit (1929) who describes the conditions that affected lichen growth in the neighbourhood of Prague; climate, soil and orientation to light and shade were important factors. Rudolf Riehmer (1932) has given attention to the mosaic of lichens on the bark of trees in South Africa, and the succession of species. *Lecanora leprosa* is signalled as a forceful species. Pertusariae also were strong growing forms that ousted the earlier arrivals. Finally arrived foliose and fruticose species chiefly *Parmelia perforata* and *Usnea florida* as dominant plants. Lucy Raup (1930) investigated the lichen flora of *Picea canadensis* at Lake Athabasca, and she also found that lichens grew mostly on the upper side of the branches. Fourteen different species were determined, the most common *Buellia disciformis*. *Xanthoria lychnea* was also abundant. Fruticose lichens were plentiful on dead branches.

Saxicolous associations. Du Rietz (1931) has made an interesting study of lichens in snow-fields—as chionochorous plants. He distinguishes two classes: those that grow on wind-swept rocks where there is little or no snow are "chionophobous" species, and those that are covered with snow in winter "chionophorous." The former are the more numerous. Fran Kusan (1930) touches on the same subject in her geographical distribution of *Cetraria islandica*: in Jugo-Slavia, in the Carpathians and in the Alps on high mountains it is to be found on wind-swept situations free from snow. M. and Mme Moreau (1932) also publish studies of the higher reaches of Monts Dore. These altitudes are covered with snow for about six months of the year. The larger types of lichen fail to exist; crustaceous forms are numerous, also those with minutely leafy thalli and of rapid growth such as *Parmelia stygia* and *P. encausta*. The same writers have made a study of lichens on the volcanic rocks in Auvergne as represented by "cheires"—narrow streams of lava from ancient volcanoes. Mostly these are covered with vegetation, but when broken up and exposed they support an abundant growth of crustaceous species. A study on similar lines by P. Genty gives the flora of the îlots—protrusions of ancient granitic rocks: the lichens were much the same as the forms that occur on similar granites elsewhere.

Another special study by Kobendza and Motyka (1929) concerns a group of rocks, the "éboulis"—piles of rock debris on the summits of the hills in Poland and Czecho-Slovakia. A Cladonietum was observed close to a forest, but well exposed to sunlight and wind. Of special interest was an association of Gyrophorae, Parmeliae and

others not otherwise found in Poland. Motyka concludes that these lichens date back to the last glacial era and to the retreat of the ice. Similar high mountain species occur in the Harz and the Sudètes, and these mountains he considers might be "nunataks." Boris Keller describes the lichen flora of rock and soil in the Volga river valley, some species endemic, others with a wide distribution. The salt in the soil gave a possible halophyte flora, as at a depth of 15 cm. there was a high proportion of sodium chloride. The associated flowering plant vegetation was definitely halophytic, and one lichen commonly present, *Telochistes brevior* var. *halophila*, is also typical of the borders of a salt lake near Astrakan.

It is with deep personal regret that I record the passing away of Matilda C. Knowles on April 27th, 1933. She had been for many years Botanical Assistant in the Herbarium of the National Museum, Dublin, where her wide knowledge of Irish plants was freely given to all who sought her aid. In later years she specialised with great zest on the study of lichens. "The maritime and marine Lichens of Howth" published in 1913, and "The Lichens of Ireland" in 1929, remain a monument to her skilled and accurate observation: the former an ecological study of lichens of the sea coast, the latter a record of lichens for the whole of Ireland—many of these latter collected and all of them, when possible, microscopically examined by herself. Her gay humour and her loyal comradeship will not easily be forgotten by those who were privileged to know her.

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—— "La Classification des Gyrophorales." *Bull. Soc. Roy. de Belgique*, lxiv (1931), 119–23, 4 figs.

Choisy, M. et Werner, R. G. "*Solenopsora Montagnei* (E. Fr.) Choisy et R. G. Wern. nov. comb. et le genre *Solenopsora* (Massal.) emend." *Bull. Soc. Hist. Nat. Afr. Nord*, xxii (1931), 7–12, 2 figs.

The writers classify the genus as near to *Rinodina* (Physciaceae). Incidentally they deprecate a too slavish use of spore characters in classification.

Crespi, L. "Notas liquenológicas." *Bol. Real Soc. esp. Hist. Nat.* xxx (1930), 261–9.

Crespi deals with *Rhizocarpon* in Spain: nine species are described.

Cretzoiu, P. "Contributiuni la flora lichenologica a judetelor Basov si Târnava-Mare." *Bull. Jard. Mus. Bot. Univ. Cluj Roumanie*, x (1931), 205–9. Roumanian. See *Hedwigia*, lxxii (1932), Beibl. p. 89. Paper not seen.

—— "Lichenii diu regunea muntilor Bucegi. I. (Lichens from the Bucegi mountains.)" Roumanian with French and German summary. *Revista Pădurilor Bucuresti* [1930], n. 12, pp. 1, 15. See *Hedwigia*, lxxii (1932), Beibl. p. 212.

List of lichens from South Carpathia.

—— "Contributiuni la flora lichenologica a României." *Bull. Soc. Studentilor in Stünte Naturale, Bucuresti*, ii (1931), 11. Roumanian with German résumé. See *Bot. Centralbl.* clxii (1932), Lit. p. 39. Papers not seen.

Cuthbert, J. B. "Some notes on the Physiology of *Teloschistes flavicans*." *Trans. Roy. Soc. S. Africa*, xix (1930), 27–44, 1 pl., 6 figs.

Darbishire, O. V. "Observations on the margin of *Pertusaria communis* (L.) D. C." *Trans. Brit. Mycol. Soc.* xvi (1931), 38–54, 2 pls.

—— "Weiteres über die Cephalodien von *Peltigera aphthosa* L." *Ber. Deutsch. Bot. Ges.* l (1932), 178–84, 1 pl.

Degelius, Gunnar (Nilsson). "Bemerkungen über *Cyphelium Notarisii* (Tul.) Blomb. et Forss. und *C. tigillare* Ach." *Bot. Not.* (1930), pp. 105–28, 3 text-figs.

The author has clearly established the difference between the two species—submuriform spores in the former, distinctly 1-septate in the more common *C. tigillare*.

—— "Lichenologiska bidrag. III." *Tom. cit.* pp. 344–59, 1 fig. Swedish with German résumé.

—— "Lichenologiska bidrag. IV." *Op. cit.* (1932), pp. 278–94, 2 figs. Swedish with German résumé.

Degelius records the finding of *Parmelia revoluta* new to Sweden and several other species, with a new form of *Siphula ceratites*.

Degelius, Gunnar (Nilsson). "*Stereocaulon incrustatum* Flk., en för Sverige ny lav." *Bot. Not.* (1932), pp. 300–1, 1 fig.

—— "Några lavar från Helgeland i Norland." *Nyt Mag. Naturv.* lxx (1932), 289–95.

An interesting and varied record of lichens from Northern localities.

—— "Zur Flechtenflora von Ångermanland." *Arkiv för Botanik*, xxiv (1931), 1–122.

—— "Zur Flechtenflora des Südlichsten Lapplands (Åsele Lappmark). I." Strauch und Laubflechten, 1 map, 8 figs. *Op. cit.* xxv (1932), 1–72.

—— "Nordiska Fyndorter för *Parmelia caparata* (L.) Ach." *Svensk Bot. Tidskr.* xxvi (1932), 332–45, 2 figs. Swedish with German résumé.

This lichen is rather rare in northern countries. Degelius considers it as a relict of the first glacial period warmth, rather than as a recent importation.

De Toni, G. B. *L' Opera lichenologica di Abramo Massalongo.* Commemorazione secolare di Abramo Massalongo, pp. 1–60, 9 col. plates. Verona (1933, xi).

A review of Massalongo's work for Lichenology compiled by De Toni before his death. The plates have been arranged by A. Zahlbruckner.

Dieckhoff, H. "Beiträge zu einer Flechtenflora von Wesermünde. Schrift. Ver. f. Naturkunde a. d. Unterweser." *Beitr. z. Naturkunde Nordwest-Deutschlands*, N. 5 (1931), pp. 41–54. *Hedwigia*, lxxii (1932), Beibl. p. 89. Paper not seen.

Dostoinova, E. J. "Zur Flechtenflora des Gouv. Vologda." *Bull. Jard. Bot. Princ. U.R.S.S.* xxix (1930), 570–81. Russian with short German note.

The author gives an account of the region, and a list of 83 species collected and named by her—a representative collection.

Du Rietz, G. Einar. "Studier över vinddriften på snöfält i de skandinaviska fjällen." *Bot. Not.* (1931), pp. 31–44. Swedish with English summary.

Studies on the wind-drift on snow-fields of Scandinavian mountains. A contribution to the dispersal-ecology of Scandinavian alpine lichens.

—— "Zur Vegetationsökologie der ostschwedischen Küstenfelsen. Festschrift Achtzigst. Geburtst. Oscar Drude." *Beih. Bot. Centralbl.* xlix (1932), 61–112, 3 pls.

Elenkin, A. A. "Le Système combinatif de Lichens basé sur les faits de leurs relations phylogéniques." *Journ. Soc. Bot. Russie*, xiv (1929), 133–64.

—— "Sur les relations réciproques des systèmes généalogique et combinatif basées sur la classification des lichens." *Tom. cit.* pp. 233–54, 4 text-figs. Russian with French résumé.

Elenkin, A. A. et Hollerbach, M. M. "Sur la place qu'occupe *Leptogium Issatchenkoi* Elenk. dans le système des lichens gélatineux, rattachée à la question de l'importance des variations individuelles (réversibles) et héréditaires (irréversibles)." *Journ. Soc. Bot. Russie*, xv (1930), 241–57. Russian with French résumé.

Elfving, Feodor. "Weitere Untersuchungen über Flechtengonidien." *Acta Soc. Sci. Fenn.* Nova series 8, 1 (1931), 1–30, 13 pls.

Erichsen, C. F. E. "Lichenologische Beiträge." *Hedwigia*, lxx (1930), 216–33, 1 text-fig.

—— "Neue Skandinavische Flechten." *Nyt Mag. Naturv.* lxviii (1930), 159–65. Three new species of crustaceous maritime lichens for Scandinavia.

—— "*Staurothele catalepta* (Ach.) Zschacke, nov. var. *fluviatilis* Erichs., eine Charakterflechte des Tidengebiets der Unterelbe." *Festschrift Bot. Ver. Hamburg*, 1891–1931 (1931), pp. 24–33, 2 figs., 1 map.

—— "Lichenologische Beiträge. II." *Hedwigia*, lxxii (1932), 75–91, 1 map, 1 fig. New species and varieties for Northern Germany. One a *Physcia* with orange-coloured soralia.

—— "Neue und bemerkenswerte atlantische Flechten im deutschen Küstengebiet." *Op. cit.* lxxiii (1933), 1–24.

—— "Die Flechten am Dummersdorfer Traveufer bei Lübeck." *Das Linke Untertraveufer Denkmalrat, Lübeck* (1932), pp. 126–53, 2 pls., 1 fig.

Evans, A. W. "The Cladoniae of Connecticut." *Trans. Connect. Acad. Arts and Sciences*, xxx (1930), 357–510.

Evans, A. W. "Notes on the Cladoniae of Connecticut." *Rhodora*, xxxiv (1932), 121–42; *tom. cit.* pp. 153–64.

An addition to the earlier report on the Cladoniae of Connecticut. Several have been added giving a total of 49 species for the State. Many notes on the species are included.

Felippone, F. "Contribución a la flora liquenológica del Uruguay." *Rev. Chil. Hist. Nat.* xxiii (1929–30), 269–71, 1 pl.

Foriss, F. "Heves község zuzmoi. (Die Flechten der Gemeinde Heves.)" *Bot. Közlem.* xxviii (1931), 180–9. Hungarian and German. (See *Bot. Centralbl.* clxii, Lit. p. 39.) Paper not seen.

Frey, Eduard. "Flechten." *Ber. Schweiz. Bot. Ges.* xxxix (1930), 56–63.

Records of lichens and publications referring to Switzerland.

—— "*Parmelia centrifuga* (L.) Ach. und *P. incurva* (Pers.) Fries in den Alpen." *Mitt. Naturforsch. Ges. Bern* (1930), pp. lxv–lxvi.

—— "Weitere Beiträge zur Kenntnis der Umbilicariaceen." *Hedwigia*, lxxi (1931), 96–119, 8 figs.

—— "Die Spezifizität der Flechtengonidien." *Ber. Schweiz. Bot. Ges.* xli (1932), 180–98.

—— "Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. IX." *Flechten*, Abt. iv, Lief. 1. Cladoniaceae (unter Ausschluss der Gattung *Cladonia*); Umbilicariaceae. Lief. 1 (1932), pp. 1–208, 32 figs. Lief. 2 (1933), pp. i–x, 209–426, 32 figs., 8 pls.

Galle, László. "Szegedi zuzmóassociatiók." *Folia Crypt.* 1 (1930), 933–46. Hungarian with German résumé.

The author lists the lichens of different associations. I–VI are from trees; VII from wooden fence; VIII from andesite rocks; IX and X from buildings. A new form of *Parmelia furfuracea* was found by him.

Gallefossé, J. et Werner, R. G. "Catalogus lichenum Marocanorum adhuc cognitorum." *Bull. Soc. Sci. Nat. Maroc*, xi (1931), 187–257. See *Bot. Centralbl.* clxiv (1933), 72.

Galloe, O. *Natural History of the Danish Lichens. Original investigations based upon new principles.* Part ii. Copenhagen, 84 pp., 128 pls. (1929). See *Bot. Centralbl.* clix (1930), 104.

Genty, P. A. "Florules des îlots granitiques des environs de Dijon." *Bull. Soc. Bot. France*, lxxix (1932), 667–86.

A list of the lichens that occur on four different granitic protrusions about 20 kilomètres west of Dijon.

Gerber, Kurt. "Die epiphytische Verbreitung von Flechtenparasiten." *Arch. f. Protistenk.* lxxiv (1931), 471–89, 20 figs.

Ginzberger, A. "Beitrag zur Kenntnis der Flechtenflora des Gran Sasso-Gebietes (Abruzzen)." *Hedwigia*, lxxi (1931), 206–14

The lichens, collected at considerable altitudes, were examined by Steiner and by Zahlbruckner. A new genus *Ginzbergerella* (Ephebaceae) has been determined by Zahlbruckner.

Goebel, K. "Morphologische und biologische Studien." *Ann. Jard. Bot. Buitenzorg*, xxxix, Rückblick xv, Thallophyten, 1 (1928), 204–8.

Grummann, V. J. "Lichenologische Berichte. I." *Repertorium*, xxix (1931), 310–19.

Biological and systematic notes on German lichens. Corticolous habitats are given.

Gyelnik, V. "Lichenes nonnulli novi criticique." *Nyt Mag. Naturv.* lxviii (1930), 269–70.

Diagnoses of new species or varieties of *Peltigera* and of a new variety of *Solorina bispora*. The 7 specimens are from Java, America and Europe.

—— "Eine neue *Peltigera*-Art aus Kola-Lappland." *Mem. Soc. Faun. et Flor. Fenn.* vii (1931), 143–5, 2 figs.

The new species *Peltigera ponojensis* Gyel. differs from *P. spuria* only in its much larger size.

Gyelnik, V. "*Parmelia glabra* (Schaer.) Nyl. alakköre. Les formes du *Parmelia glabra* (Schaer.) Nyl." *Magyar Bot. Lapok* (1930), pp. 15–18. Hungarian with French résumé.

Notes as to the sorediate or pilose character of the species. Gyelnik considers that the pilosity indicates a different plant as do the soredia in var. *sorediomanes*.

—— "Cladoniae Hungaricae a G. Timkó lectae." *Tom. cit.* pp. 22–3.

Noteworthy species from a collection made by Timkó and determined by Vainio.

—— "Lichenologiai Közlemények (20–45)." *Tom. cit.* pp. 23–35, 2 pls.

New species and varieties or forms are described.

—— "Revisio Peltigerarum Herbarii Achariani." *Tom. cit.* pp. 49–58.

—— "Ochrolechia nonnullae novae." Fedde, *Rep. Spec. nov. reg. veg.* xxvii (1930), 391–2. German.

Three sorediate species (one with rose-coloured soredia), closely related, from Hungary, Herzegovina and Germany.

—— "Lichenes extraeuropaei novi criticique." *Op. cit.* xxix (1931), 1–10.

A critical review and rearrangement of herbarium lichens (chiefly Lobarina and Sticta) from many parts of the world.

—— "Squamaria nonnullae." *Tom. cit.* pp. 40–1.

Species of *Squamaria* from various parts of Hungary: some of them new species, others varieties new to science. Habitat and localities are given.

—— "*Parmelia Pokornyi* rokonsági köre és leszármazása. The relationship and descendence of *Parmelia Pokornyi*." *Tom. cit.* pp. 45–52.

Parmelia Pokornyi and *P. addanubica* are allied to *P. delisei*. Gyelnik gives the distribution of the two former and describes new forms.

—— "Alectoriae nonnullae novae vel minus cognitae." *Tom. cit.* pp. 53–4.

New forms and two new species of *Alectoria* are described.

—— "Lichenes suecici novi." *Op. cit.* (1932), pp. 46–7.

Gyelnik publishes *Alectoria Vrangiana* akin to *A. jubata*. Varieties of *Peltigera* and a variety of *Nephroma reagens*, all from Suecia.

—— "Nephroma novae et criticae." *Ann. Crypt. Exot.* iv (1931), 121–48.

Many new species, varieties or forms are published with a key to the genus *Nephroma*.

—— "Ramalinae duae novae e Paraguay." *Tom. cit.* pp. 150–1.

One of the species recorded differs from *R. fraxinea* in the reaction—K+ instead of K−.

—— "Additamenta ad cognitionem lichenum extraeuropaeorum." *Tom. cit.* pp. 166–74.

A considerable number of lichens from non-European countries are recorded, many of them new to science. A large proportion is from America.

—— "Peltigerae novae et rarae." *Op. cit.* v (1932), 39–40.

Peltigerae from various countries; one new to science *P. subhorizontalis* from N.S. Wales, Australia, somewhat similar to *P. horizontalis*, but with white veins.

—— "Was ist *Solorina sorediifera* Nyl.?" *Tom. cit.* pp. 41–2.

The author has classified the species as *Peltigera leptoderma*.

—— "Additamenta ad cognitionem Parmeliarum. I." *Rep. Spec. nov. reg. veg.* xxix (1931), 149–57.

An account of many new forms and several new species. Isidiose forms bulk largely.

—— "Additamenta. II." *Tom. cit.* pp. 273–91.

The paper deals with Xanthoparmeliae in Europe. Great use is made of reactions and a number of new species are described. A key to the group is provided.

—— "De Stitacaeis nonnullis." *Tom. cit.* pp. 292–300.

Descriptions are given of various species of *Lobaria*, *Sticta*, etc., and a key to the European species.

GYELNIK, V. "Additamenta ad cognitionem Parmeliarum. III." *Rep. Spec. nov. reg. veg.* XXX (1932), 209–26.

Gyelnik has given a list of Parmeliae from the Museum, Budapest. He has also given a "System" of the Parmeliae of Europe with sections and sub-sections.

—— "Notes on *Peltigera*." *Bryologist*, XXXIV (1931), 16–19.

Two new species are described, *P. Evansiana* from New England and *P. chilensis* from Chili. Both isidiose forms. A key to the isidiose species of the entire world is added.

—— "Some Lichens of Oregon." *Mycologia*, XXIV (1932), 342–4.

Species of *Peltigera* and *Nephroma* sent to V. Gyelnik by Prof. F. P. Sipe of Cornwallis, Oregon.

One new species, *Nephroma Sipeanum*, is described along with two new varieties and a new form of *Nephroma* sp.

—— "Lichenes foliacei nonnulli novi vel rari." *Rev. Bryolog. et Lichenolog.* V (1932), 31–3.

A list of lichens rearranged and renamed by the author.

—— "Enumeratio lichenum europaeorum novorum, rariorumque." *Ann. Mycol.* XXX (1932), 442–55.

Gyelnik has published a study of the lichens in the Hungarian National Museum at Budapest belonging to the genera *Parmelia* and *Gyrophora*.

—— "Ueber einige Arten der Gattung *Parmeliopsis* (Stizenb.) Nyl." *Tom. cit.* pp. 456–9.

Gyelnik divides *Parmeliopsis* into two sections: (1) *Viridifera*, and (2) *Pallidifera*. Several new varieties and forms are described.

—— "Lichenologische Substratstudien (*Squamaria radiosa* Gruppe)." *Hedwigia*, LXXI (1931), 120–32.

—— "*Nephroma* Studien." *Op. cit.* LXXII (1932), 1–30, 2 figs.

—— "*Alectoria* Studien." *Nyt Mag. Naturv.* LXX (1932), 35–62.

HANTSCH, BERNARD. "Contributions to the Knowledge of extreme North-Eastern Labrador. XLV." *Lichens* (1931), p. 173.

A list of plants is given, including lichens; seven species are recorded, with the popular names.

HARSHBERGER, J. W. "The vegetation of Campos de Jordão, Brazil." *Proc. Amer. Philos. Soc.* LXVIII (1929), 83–92.

A few lichens are recorded (p. 89). One of the specimens, *Usnea cinchonarum* A. Zahlbr., has been determined by Dr Motyka as *U. radiata* Stirton.

HAUGSJÅ, PÅL K. "Ueber den Einfluss der Stadt Oslo auf die Flechtenvegetation der Bäume." *Nyt Mag. Naturv.* LXVIII (1930), 1–116, 10 pls.

HÄYRÉN, ERNST. "Einige Flechten aus Estland." *Mem. Soc. Faun. et Flor. Fenn.* VI (1929–31), 122–8.

A list of lichens with notes as to habitat and locality.

—— "*Gyrophora fuliginosa* Håvas aus Finnland." *Tom. cit.* p. 180.

An account of the plant as it occurs in Finland.

HEDRICK, JOYCE. "New Species of Lichens from Porto Rico. IV." *Mycologia*, XXII (1930), 247–55.

Descriptions of 25 lichens determined by Bruce Fink and G. K. Merrill; one new genus *Leucogymnospora* (Graphidaceae) is included.

—— "Lichens from the State of Oklahoma." *Mich. Acad. Sci. Arts and Letters*, XIII (1931), 101–10.

Oklahoma in the South-West of the Great Plains furnished 22 genera with 59 species.

HILITZER, ALFRED. "Addenda ad Lichenographiam Bohemiae." *Acta Bot. Bohemica*, VIII (1929), 104–18.

A varied series of lichens, some of them new to Bohemia.

HILLMANN, JOHANNES. "Einige Bemerkungen über die roten Usneen." Fedde, *Rep. Spec. nov. reg. veg.* XXVII (1930), 287–91.

Hillmann finds that the first red *Usnea* described was *U. florida* var. *rubiginosa* Mich. from Canada. He decides that the other red species are also varieties of green Usneae.

Hillmann, Johannes. "Beiträge zur Flechtenflora Bayerns. I." *Krypt. Forsch. München*, II (1931), 225–39.
A list of Bavarian lichens revised and brought up to date.
Hoeg, Ove Arbo. "A Note on the Character of the Lichen Flora at Victoria Falls." *Kongelige Norsk. Vidensk. Selsk. Forhandl.* IV (1931), 93–5.
There were few lichens to be found, and no evidence of any previous tropical forest. The lichens seen were widespread species.
Hollerbach, M. M. "Notes sur la Morphologie et la Biologie de *Leptogium Issatschenkoi* Elenk. dans les conditions naturelles d'habitation." *Bull. Jard. Bot. Princ. U.R.S.S. Leningrad*, XXIX (1930), 320–2, 2 pls.
In normal conditions neither cortical layers nor rhizinae are present. Any irritant such as contact with other lobes or with mosses on which it grows induces the formation of cortex and rhizinae.
Inhelder, J. "Beiträge zur Moss- und Flechtenflora des Obertoggenburgs." *Jahrbuch St-Gall. Naturwiss. Ges.* LXV (1929–30), 131–6. See *Bot. Centralbl.* CLIX (1930), 104.
Jaag, O. "Morphologische und physiologische Untersuchungen über die zur Gattung *Coccomyxa* gehörenden Flechtengonidien." *Verh. Schweiz. Nat. Ges.* CXII (1931), 331–2.
Jeanjean, A.-F. "Le *Pannaria squamulata* Hue dans le Sud-Ouest de la France." *Proc. Verb. Soc. Linn. Bordeaux*, LXXX (1928), 52–3.
A record of this somewhat rare lichen found on poplars near Nantes. Another rare species, *Coniocype pallida* Fr. var. *farinosa* Harm., was collected at Deux-Sèvres at the base of *Acer campestre*.
Jones, Jessie. "An investigation into the Bacterial Associations of some Cyanophyceae, with Especial Reference to their Nitrogen Supply." *Ann. Bot.* XLIV (1930), 721–40.
Jones, S. G. "A Study of Apothecial Development in the Leaf-Spot Disease of Red Clover." *Trans. Roy. Soc. Edin.* LVI (1930), 507–19, 9 text-figs.
Kaule, Albert. "Die Cephalodien der Flechten." *Flora*, CXXVI (1931), 1–44, 16 figs.
Keissler, Karl von. "Die Flechtenparasiten." Rabenhorst's *Kryptogamen-Flora*, VIII (1930), 1–712, 135 text-figs.
—— "Zusammenstellung einiger interessanter Flechtenparasiten." *Beih. Bot. Centralbl.* L (1933), 380–94.
An account of lichen parasites mostly from non-European countries.
Keller, Boris. "Die Erdflechten und Cyanophyceen am untern Lauf der Volga und des Ural." *Vegetationsbilder*, Reihe 20, Heft 8, Tafel 43–8 (1930).
Klein, Edm. J. "Die Verteilung der Flechten und Moosvegetation auf dem Geländer der neuen (Adolph-) Brücke." *Ges. Luxem. Naturf., Monatsber.* N.F. XXIII (1929), 126–7. See *Hedwigia*, LXX (1930), Beiblatt, p. 56. Paper not seen.
Klement, Oskar. "Zur Flechtenflora des Erzgebirges. Die Umgebung von Komotau." *Beih. Bot. Centralbl.* XLVIII (1931), Abt. II, pp. 52–96.
Klika, Jaromir. "Studien über die Xerotherme Vegetation Mitteleuropas. I." *Beih. Bot. Centralbl.* XLVII (1931), 343–98.
Special reference to lichens on the sun-baked rocks occurs among the plant associations, pp. 354–7.
Knight, H. H. "Lichens of the Whitby Foray." *Trans. Brit. Mycol. Soc.* XVI (1931), 17–18.
Kobendza, R. et Motyka, J. "La végétation des éboulis des Monts de Ste Croix." *Bull. Acad. Polonaise Sci. et Lettr.* Cl. Sci. Math. et Nat. (1929), pp. 175–207, 6 pls.
Kusan, Dr Fran. "Lichen islandicus (*Cetraria islandica*) u Jugoslaviji." *Vjesnika Ljekarnika*, XII (1930), 1–8, 3 figs.
—— "Die Flechten." *Prirodoslovna istrazivanja*, XVI (1930), 159–62.
—— "Neue Beiträge zur Flechtenflora des Kroatischen und Dalmatischen Küstenlandes." *Acta Bot. Inst. Bot. Univ. Zagreb*, V (1930), 18–47, 3 figs.

Kusan, Dr Fran. "Additamenta ad floram lichenum Bosnae et Hercegovinae." *Acta Bot. Inst. Bot. Univ. Zagreb*, VI (1931), 1–18.

A list of lichens from the above countries determined by Fran Kusan.

—— "Ueber die systematische Bewertung gewisser Merkmale im Formenkreise von *Parmelia conspersa* sensu lat." *Acta Bot. Inst. Bot. Univ. Zagreb*, VII (1932), 1–34.

—— "Ueber die angebliche *Cladonia pycnoclada* (Gaudich) Nyl. in Jugoslavien." *Hedwigia*, LXXII (1932), 42–54.

Ladyshenskaja, C. "Oekologisches Verzeichniss der Flechten in der Umgebung der Stadt Kologriv." *Journ. Soc. Bot. Russie*, XVI (1931), 544–53, 2 figs. Russian with German summary.

Liou, Tchen-Ngo. "La Végétation épiphytique des bois de Conifères." *Bull. Soc. Bot. France*, LXVI (1929), 21–30.

Succession and Associations of lichens on Pine trees—crustaceous, then foliaceous and later fruticose species.

Lynge, Bernt. "*Cornicularia divergens* Ach. found fertile in Europe." *Nyt Mag. Naturv.* LXVII (1929), 131–6.

Lynge records that the lichen had previously been found fertile only in Asia. It has now been found on the Doore Mountain "bearing several fine apothecia."

—— "*Rhizocarpon nitidum* Lynge n.sp." *Mem. Soc. Faun. et Flor. Fenn.* VII (1931), 145–6, 1 fig.

Descriptions of a new species from Fennia. The medulla becomes blue with iodine.

—— "Lichens collected on the Norwegian Scientific Expedition to Franz Josef Land 1930." *Skrifter om Svalbrad og Ishavet*, N. 38 (1931), pp. 1–31, 1 map, 2 pls.

—— "Lichens from South East Greenland collected in 1931 on Norwegian Expeditions." *Op. cit.* N. 45 (1932), pp. 1–15.

—— "A Revision of the genus *Rhizocarpon* (Ram.) Th. Fr. in Greenland." *Op. cit.* N. 47 (1932), pp. 1–30.

—— "Om Ulbredelsen av Endel Arktiske Laver." *Svensk Bot. Tidskr.* XXVI (1932), 401–30.

An account (with list) of lichens from Nova Zembla, N.E. Greenland and Norway. Circumpolar lichens are also enumerated. Flowering plants are included in the survey.

—— "Lichens of the Godthaab Expedition 1928." *Kommissionen Vidensk. Undersøgelser i Grønland*, LXXXII (1932), 3, pp. 3–8.

The lichens were collected in Greenland and in Baffin Island. Lynge identified 43 different species.

Lynge, B. and Scholander, P. F. "Lichens from North East Greenland collected on the Norwegian Scientific Expeditions in 1929 and 1930." *Skrift.* N. 41 (1932), pp. 1–116, 1 map, 7 pls. Oslo.

Magnusson, A. H. "The Lichen genus *Acarospora* in New Mexico." *Göteborgs Bot. Trädgärd*, V (1930), 55–72.

—— "New or otherwise interesting *Lecanora* species." *Op. cit.* VI (1931), 1–20.

Detailed, critical account of northern Lecanorae.

—— "Studien über einige Arten der *Lecidea armeniaca*- und *Elata*gruppe." *Tom. cit.* pp. 93–144.

The lichens are mostly of world-wide distribution. A key is furnished; many "species" are reduced to varieties or forms.

—— "Beiträge zur Systematik der Flechtengruppe *Lecanora subfusca*." *Op. cit.* VII (1932), 65–87.

—— "Monograph of the Lichen Genus *Ionaspis*." *Op. cit.* VIII (1933), 1–47.

—— "Gedanken über Flechtensystematik und ihre Methoden." *Tom. cit.* pp. 49–76.

—— "Edvard August Vainio (1853–1929)." *Ann. Crypt. Exot.* III (1930), 5–12, 1 pl.

Magnusson gives in this paper an account of Wainio's monumental life-work for Lichenology. To that is added a complete list of his published works.

Magnusson, A. H. "Lichens from Western North America, mainly Washington and Alaska." *Ann. Crypt. Exot.* v (1932), 16–38.

Magnusson publishes 11 new species belonging to various genera of mostly crustaceous lichens. He gives also a list of species from North America determined by him: Cladoniae, Parmeliae, etc.

—— "New or interesting Swedish lichens. VI." *Bot. Not.* (1930), pp. 459–76.

—— "New or interesting Swedish lichens. VII." *Op. cit.* (1932), pp. 417–44.

A careful and instructive examination of species found in Sweden (already known), with descriptions of new species and many new varieties.

Maheu, Jacques. "Lichens d'Aix-en-Provence (1926–27)." *Bull. Soc. Bot. France*, lxxvii (1930), 597–611.

—— "Lichens d'Aix en Provence (1926–27)." *Op. cit.* lxxviii (1931), 75–89.

A list of 181 lichens including rare and new species.

Malme, Gust. O. A. N. "Ett Bidrag till Spetsbergsöarnas Lavflora." *Svensk Bot. Tidskr.* xxiv (1930), 298–300.

List of the lichens brought back in 1898 from Kung Karls Land and other localities, mostly fruticose and foliose species. The botanists of the expedition were Gunnar Anderson and Henrik Hesselman.

—— "Två märkliga lavfynd på ön Karta i Sorunda (Södertörn)." *Op. cit.* xxv (1931), 271–2.

The two rare species are *Caloplaca chalybaea* and *Staurothele rupifraga*, both of them calcicolous lichens.

—— "*Verrucaria aquatilis* Mudd, en sotvattenslav, antraffad i Sverige." *Op. cit.* xxvi (1932), 459–60.

Notes on the above lichen, new to Sweden, and on other aquatic or semi-aquatic species.

—— "Porinae et Phylloporinae in Itinere Regnelliano primo collectae." *Arkiv för Botanik*, xxiii (1930), N. 1, pp. 1–37.

—— "Lichenes orae Sibiriae borealis inde ab insula Minin ad promontorium Ryrkajpia in expeditione Vegae lecti." *Op. cit.* xxv (1932), N. 2, pp. 1–42.

Malme gives an interesting account of the region where Almquist collected lichens about fifty years ago. The collection had already been examined and partly determined.

—— "Lavar fran Dalarnes siluromräde (Lichenes in regione silurica Dalecarliae lecti)." *Bot. Not.* (1932), 1/2, pp. 105–22.

Mameli-Calvino, Eva. "Pugillo di Licheni dell' Abissinia e dell' Eritrea." *Nuovo Giorn. Bot. Ital.* xxxvii (1930), 255–8.

The lichens enumerated are from various districts of Abyssinia and Eritrea. Most of them new to Abyssinia, some of them new to Africa.

—— "Ricerche su una Forma singolare di Deuterolichene *Chloro-cyphella subtropica* Speg." *Tom. cit.* pp. 369–79, 1 pl.

Mattfield, Joh. "Karl Schulz-Korth." *Verh. Bot. Ver. Prov. Brandenburg*, lxxiii (1931), 141–52, with photographic plate.

An account of the life of Karl Schulz-Korth, with an appreciation of his work.

Mattick, Fritz. "Mikroklimatische und Vegetationsuntersuchungen auf der Insel Vilm (Rügen)." *Beih. Bot. Centralbl.* xlvii (1931), 399–420, 6 pls., 1 map.

Lichens were included in the survey: they were recorded on pines, thorns, in dry meadows and on rocks by the shore.

—— "Bodenreaktion und Flechtenverbreitung. Festschr. Achtzig. Geburtstage Oscar Drude." *Op. cit.* xlix (1932), 241–71.

Mayfield, Arthur. "The Hepatics, Mosses and Lichens of Suffolk." *Ipswich and District Nat. Hist. Soc.* 1 (1930), 2, 29–52.

A complete list of Suffolk lichens so far as known. The writer notes the abundance of corticolous species and the rather scanty representation of saxicolous forms.

Meylan, Ch. "Fortschritte der Floristik." *Ber. Schweiz. Bot. Ges.* xxxviii (1929), 108–21.

An account of various lichens occurring in Switzerland.

MEYLAN, CH. "Troisième contribution à la connaissance des lichens du Jura." *Bull. Soc. Vaud Sc. Nat.* LVII (1930), 213–18.

A considerable addition to the Lichen-flora of the Jura. A number of species are new to Switzerland. Meylan finds the Haut-Jura rich in lichens.

MIGULA, W. "Kryptogamen-Flora von Deutschland, Deutsch-Österreich und der Schweiz." *Flechten*, IV (1929–31), 527–868, 150 pls. mostly coloured.

MOORE, JOHN ADAM. "A new Species of Parmelia from Texas." *Ann. Miss. Bot. Gard.* XIX (1932), 503–4.

The new species is allied to *P. caperata* but differs in the presence of white dots on the thallus and in the absence of reactions with KOH and CaCl.

MOREAU, M. et MME FERNAND. "Étude systématique, écologique et sociologique des Lichens saxicoles des environs de la Station biologique de Besse (Puy de Dôme)." *Bull. Soc. Bot. France*, LXXVII (1930), 479–90.

—— "Les synapses des Champignons supérieurs." *Tom. cit.* pp. 513–17, 35 text-figs.

—— "Notes lichénologiques. No. XXV." *Op. cit.* LXXVIII (1931), 726–31.

Mostly descriptions of new lichens. The authors substitute the generic name *Parmularia* for *Squamaria*.

—— "Sur le peuplement de cheires volcaniques d'Auvergne." *Bull. Soc. Bot. France*, LXXIX (1932), 5–10.

—— "Observations sur les Lichens d'altitude dans la région méridionale des Monts Dore." *Tom. cit.* pp. 44–61.

—— "Sur un Lichen du genre *Stereocaulon* Schrab. le *S. coralloides* Fries." *Tom. cit.* (1932), pp. 508–15, 5 figs.

—— "Lichens recueillis en 1930 dans les îles Kerguélen, Saint-Paul et Amsterdam par M. Aubert de la Rue." *Ann. Crypt. Exot.* IV (1931), 98–103.

—— "Recherches sur les Lichens du genre *Dermatocarpon*." *Rev. Gén. Bot.* XLIV (1932), 305–15, 4 pls.

MORUZI, C. "Remarques sur quelques lichens récoltés en Roumanie dans les districts de Neamtz et Bucegi." *Bull. Sect. Scientif. Bucarest*, XIV (1931), 89–105, 9 figs. (See *Bot. Centralbl.* CLXII (1932), Lit. p. 39.) Paper not seen.

—— "Recherches cytologiques et expérimentales sur la Formation des Périthèces chez les Ascomycètes." *Rev. Gén. Bot.* XLIV (1932), 268–302, 11 pls.

C. Moruzi included a few lichens in her work on fruit formation.

MOTYKA, JÓZEF. "Matérjaux pour la connaissance des Lichens de Silésie." *Wydawnictwa Muzeum Śląskiego w Katowicach*, Dzial III, N. 2 (1930), pp. 1–28, 3 pls. Polish with French résumé.

NANNFELDT, J. A. "Studien über die Morphologie und Systematik der nicht-lichenisierten inoperculaten Discomyceten." *Nova Acta Reg. Soc. Sci. Upsal.* Ser. 4, VIII (1932), 1–368, 19 pls., 47 figs.

In this paper on Fungi, the Lecanorales are frequently referred to, and their relation to fungi defined as a nutrition-biological group. Notes are given on individual lichens that have been wrongly classified as fungi.

NAYLOR, GLADYS L. "Note on the Distribution of *Lichina confinis* and *L. pygmaea* in the Plymouth District." *Journ. Marine Biol. Ass. United Kingdom*, XXI (1930), 909–18, 1 text-fig.

NIKOLSKY, P. N. "Lichens new for the Viatka Region." *Bull. Jard. Bot. Princ. U.R.S.S.* XXIX (1930), 325–9.

A list of lichens collected by the author and A. D. Folkin in the N.E. of European Russia. The list contains 52 species new to the region, mostly pine forests.

OXNER, A. U. "Neue und wenige bekannte Flechtenarten in der U.S.S.R. Auszug." *Bull. Jard. Bot. Princ. U.R.S.S.* XI (1930), 56–68.

Notes of lichens mainly from southern Russia. Russian with German résumé.

PAASIO, I. "Pohjois-Satakunnen soiden jäkälistä. (Ueber die Flechten der Moore in Nord-Satakunta.)" *Ann. Soc. Zool.-Bot. Fenn. Vanamo*, XV (1931), 133–51.

Palm, B. T. "Clavarien und Algen." *Svensk Bot. Tidskr.* xxvi (1932), 175–90, 2 pls., 4 text-figs.

The association of the two organisms—a so-called "lichen," is regarded by Palm as a sclerotia-forming fungus with the alga as host-plant.

Paulson, R. "*Parmelia australiensis* Crombie—a rediscovered Species." *Journ. Bot.* lxviii (1930), 129–30, 1 pl.

The lichen determined by Paulson was collected in S. Australia. A description and history of the original plant are given.

—— "Lichens from Kaw Tao, an Island in the Gulf of Siam." *Journ. Siam. Soc. Nat. Hist.* Suppl. viii (1930), No. 2, pp. 99–101.

Puymaly, A. de. "Observations et remarques sur les lichens." *Compt. Rend. Acad. Sci.* cxciv (1932), 1600–2.

Raistrick, N. and others. "Studies in the Biochemistry of Micro-organisms." *Phil. Trans. Roy. Soc. London,* ccxxii (1931), i–iv, 1–367.

Räsänen, Veli. "*Die Flechten Estlands,* 1 (1931), 1–163. Helsinki.

First contribution to a Lichen Flora of Esthonia.

—— "Zur Kenntnis der Flechtenflora Feuerlands." *Ann. Soc. Zool.-Bot. Fenn. Vanamo,* ii (1932), 1, pp. i–vi, 1–65, 2 pls., 1 map.

—— "*Thamnolia vermicularis* (Sw.) Schaer. mit Apothecien und Sporen gefunden." *Tom. cit.* vi (1932), 11–13.

Rassadina, K. "Les Lichens recueillis par S. Ganešin dans le district de Luga et dans les environs de Novo-Sieverskaja, gouvernement de Léningrad." *Acad. Sciences U.R.S.S.* xxii (1930), 319–28. Russian with German résumé.

—— "Sur les lichens du ci-devant district de Peterhof du gouvernement de Léningrad." *Trav. Mus. Bot. Léningrad,* xxii (1930), 223–71, 4 figs. Russian with German summary. See *Bot. Centralbl.* clxi (1931), Lit. p. 8. Paper not seen.

Raup, Lucy E. "An investigation of the Lichen Flora of *Picea canadensis*." *Bryologist,* xxxiii (1930), 1–11.

—— "The Lichen Flora of the Shelter Point Region, Athabasca Lake." *Bryologist,* xxxiii (1930), 57–66, 4 pls.

Rhodes, P. G. M. "The Lichen Flora of Hartlebury Common." *Proc. Birmingh. Nat. Hist. Soc.* xvi (1931), 39–43.

The district is much affected by industrial conditions. *Lecanora conizaea* with a leprose thallus, and the quick-growing *Lecidea uliginosa* proved resistant.

Riehmer, E. "Eine neue Flechte aus Sachsen." *Hedwigia,* lxxi (1931), 305–10, 5 figs.

A new species, *Porina porphyria,* on stone. Two gonidial layers are described.

Riehmer, Rudolf. "Oekologie afrikanischer Rindenflechten." *Arch. f. Protistenk.* lxxvi (1932), 338–94, 3 pls., 10 figs.

Robbins, C. A. "Cladonias collected by S. F. Blake in the Western United States." *Rhodora,* xxxiii (1931), 135–9, 1 pl.

Robbins, C. A. and Blake, S. F. "*Cladonia* in the district of Columbia and vicinity." *Tom. cit.* pp. 145–59, 3 pls.

The two papers add to our knowledge of American Cladoniae.

Sandstede, H. Rabenhorst's *Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz.* IX. Die Flechten, Abt. iv, 2. Die Gattung *Cladonia* (1931), pp. 1–240, 241–531, 8 text-figs., 34 pls.

Savicz, V. P. "De Pyrenidiaceis e Kamezatka notula." *Bull. Jard. Bot. Princ. U.R.S.S.* xxix (1930), 99–100 (with map).

Notes on the occurrence of *Coriscium viride* Wain. in different provinces of Russia and in Alpine regions of Kamtschatka.

—— "Lichenotheca Rossica. Decas III (1930)." *Bull. Jard. Bot. Princ. U.R.S.S.* xxix (1930), 193–6.

The list includes the species *Placodium Tomini,* previously published under the generic name *Caloplaca.* It is distinguished by the scattered soredia on the squamules.

Sawyer, E. Nellie. "Note on the squamules of *Cladonia ochrochlora* Flk. var. *ceratodes* Flk." *Proc. Brist. Nat. Soc.* vii (1931), 252–8, 2 pls.

Sbarbaro, C. "Licheni italiani nuovi o interessanti." *Archivio Bot.* VI (1930), 9–15.

—— "Contributo alla Flora Lichenologica Ligure." *Op. cit.* VII (1931), 276–95.
The lichens were mostly collected in Liguria and have been determined by Bouly de Lesdain. New species and new varieties are described.

Schade, Alwin. "Die Verbreitung von *Racodium rupestre* Pers. und *Coenogonium nigrum* (Huds.) Zahlbr. in Sachsen. Festschr. Achtzig. Geburtst. Oscar Drude." *Beih. Bot. Centralbl.* XLIX (1932), 421–37.
Schade has judged *Coenogonium nigrum* to be the proper designation of the lichen though the "*nigrum*" was used not only for that plant but also for *Racodium rupestre*. He rejects *Cladophora* as the gonidium of the latter.

Schütt, Br. "Flechtenstoffe in Cladonien. I, II." *Abhandl. Naturw. Bremen*, XXVIII (1931), 87–90, 183–92.

Schulz-Korth, Karl. "Liste der auf dem Herbstausfluge des Botanischen Vereins am 9. Oktober 1927 beobachteten Flechten." *Verh. Bot. Ver. Prov. Brandenburg*, LXX (1928), 25.
Record of the lichens found during the excursion. General account (pp. 23–6) by E. Ulbrich.

—— "Bemerkenswerte Lichenenfunde aus der Mark." *Tom. cit.* pp. 55–6.
One of the most notable finds—a specimen of *Peltigera canina* covered with isidia, determined previously by Gyelnik in his "*Peltigera Studien*" as *P. subcanina* n.sp.

—— "Miscellanea lichenologica." *Rep. Spec. nov. reg. veg.* (Fedde), XXVIII (1930), 203–4.
New varieties of Peltigerae and Parmeliae from the Mark Brandenburg.

—— "Die Flechtenvegetation der Mark Brandenburg." (Dissertation.) *Op. cit.* (Fedde), LXVII (1931), 1–192, 23 pls., 45 text-figs.

—— "Lichenologische Beobachtungen bei Leuenberg (Oberbarium)." *Op. cit.* pp. 90–4 (1931).

Servit, M. "Flechten aus der Cechoslovakei." *Vestniku Král. Ces. Spol. Nauk*, pp. 1–50, 2 pls. (1929).

—— und J. Nádvorník. "Flechten aus der Cechoslovakei. II. Karpathorussland und Sudostslovakei." *Op. cit.* pp. 1–42 (1931).
A long list of species, with new localities and substratum. Some are new to science.

—— "Zur Flechtenflora des Südbanats." *Verhandl. u. Mitt. Siebenburg-Ver. Naturwiss. Hermannstadt,* LXXIX–LXXX (1929–30), 151–60. See *Bot. Centralbl.* CLIX (1930), 104.
A record of lichens from the neighbourhood of Belobrečka.

—— "Flechten aus Jugoslavien. 2. Suddalmatien und Loveen." *Hedwigia*, LXXI (1931), 215–82, 2 figs.

—— "Bearbeitung der von K. R. Rechinger (fil.) im Jahre 1927 auf den Agaischen Inseln gesammelten Flechten." *Ann. Naturhist. Mus. Wien*, XLVI (1931), 77–90, 4 figs.
A new genus of blue-green lichens is described—*Rechingeria* near to *Thyrea* but with apothecia in close groups.

Sharp, Aaron J. "Lichen as a Substratum for Mosses." *Bryologist*, XXXIII (1930), 85.
Three species of mosses were found growing on *Gyrophora Dilenii* in large patches in the Great Smoky Mountains, America.

Smith, A. Lorrain. "New Lichens. Notes from the British Museum Herbarium." *Journ. Bot.* LXX (1932), 48–9.
A new African lichen, *Arctomia muscicola*, from the Transvaal is described, and a variety of *Pertusaria multipuncta* which differs in the much larger spores.

—— "Lichens from Northern India." *Trans. Brit. Mycol. Soc.* XVI (1931), 128–32.
The lichens were sent by Professor Chaudhuri from Lahore University. One species and several new varieties are described.

Suza, Jindrick. "Lichenes Bulgariae. I." *Acta Bot. Bohemica*, VIII (1929), 7–25.
A first list of Bulgarian lichens collected on excursions to four localities. Altitudes are given and habitats.

Suza, Jindrich. "Lichenes Slovakiae. III." *Acta Bot. Bohemica*, IX (1930).

Szatala, Ö. "Beiträge zur Flechtenflora von Bulgarien. II." *Magyar Bot. Lapok*, XXIX (1930), 58–104.

A second contribution to the Lichenflora of Bulgaria. Five new species were determined. There were collected 277 species and many varieties and forms.

—— "Lichens du Maroc recueillis par M. le baron G. Andreansky en 1930." *Op. cit.* XXX (1930), 115–26.

A considerable record of species with localities, and citations of other collections.

—— "Új zusmók. II. (Neue Flechten. II.)" *Tom. cit.* XXX (1931), 135–6.

Two species of *Verrucaria*, new to science, are described, and forms of other species.

—— "Lojka Hugó hagyatékának zuzmói. Lichenes a divo H. Lojka relictae." *Op. cit.* XXXI (1932), 67–126.

—— "Beiträge zur Kenntniss der Flechtenflora von Herzegovina." *Bot. Közlem.* XXVII (1930), 1–26.

Szatala records the lichens collected in Bosnia and Herzegovina in 1918. He lists 239 species and 104 forms, many of them new to the territory.

—— "Lichenes Hungariae. II. Graphidineae, Lecanactidaceae, Peltigeraceae." *Folia Crypt.* I (1930), 834–928.

—— "Lichenum cacuminum Tatraënsium. I." *Tom. cit.* pp. 929–32.

—— "Enumeratio Lichenum a cl. F. Föriss in Galicia lectorum." *Tom. cit.* pp. 985–8.

Timkó, György. "*Thelenella pertuasiella* Vain." *Folia Crypt.* (1930), pp. 827–8.

Description of the species with a note on the synonymy.

—— "Turócer Flechten." *Tom. cit.* pp. 829–32. Hungarian and German.

A list of 72 species from S.E. Europe, collected by Margittai, and named by Timkó (Budapest).

Tobler, F. "The Organism and Development of Lichens." *Proc. Fifth Bot. Congress, Cambridge*, 1930, pp. 325–8.

—— "Erfolg und Ziel der Flechtensymbiose." *Scientia*, XLVI (1930), 237–44.

A discussion of the life-history of lichens and their systematic position as a distinct class of plants, not to be included among fungi.

—— "Der Fall des *Chiodecton sanguineum* (Sw.) Wainio. Ein Beitrag zur Stoffwechselphysiologie der Flechten." *Ber. Deutsch. Bot. Ges.* XLIX (1931), 158–66, 4 figs.

—— "Pilz und Alge bei *Chiodecton sanguineum* (Sw.) Wainio. Eine Grundsätzliche Erörterung über die Entstehung von Flechten." *Tom. cit.* pp. 274–81, 4 figs.

—— "Zur Entwicklungsgeschichte des Flechtenkörpers." *Op. cit.* L (1932), 237–47, 8 figs.

—— "Vermehrungsweise und Verbreitung bei *Cladonia*. Festschr. Achtzig. Geburtst. Oscar Drude." *Beih. Bot. Centralbl.* XLIX (1932), 482–94, 2 pls.

—— "Elfving's Untersuchungen über Flechtengonidien." *Hedwigia*, LXXII (1932), 68–74.

Tshernov, D. K. "Ueber die Verteilung der Flechten im Krimgebirge." *Journ. Soc. Bot. Russie*, XVI (1931), 536–43. Russian with German summary.

Tubeuf, Carl Freiherr von. "Bekämpfung von Flechten und Moosen, besonders in Baumschulen und Forstgärten." *Zeitschr. Pflanzenkr. und Pflanzensch.* XLII (1932), 470–9, 4 figs.

—— "Elfving's Untersuchungen über Flechtengonidien." *Hedwigia*, LXXII (1932), 68–74.

Vainio, E. A. "Duae species *Placodio gilva* (Hoffm.) affines." *Ann. Soc. Zool. Bot. Fenn.* IX (1929), 320–1.

The species described are *Placodium sorocarpum* (*Callopisina cerinum* var. *sorocarpa*), and *P. Turkuense* n.sp. from Finland.

Van der Byl, P. A. "In Lys van Korsmosse (Lichenes) versamel in de Unie van Suid-Afrika en in Rhodesië gedurende de tydperk 1917–1929." *Ann. van de Universiteit van Stellenbosch*, IX (1931), 1–17.
Species found in S. Africa.
Virville, Ad. Davy de. "Les Zones de Lichens sur le Littoral Atlantique." *Bull. Mayenne-Sciences* (1931–2), pp. 1–34.
—— "La répartition des Lichens à l'île de Cézembre." *Compt. Rend. Acad. Sci.* CXCIV (1932), 1180–2.
The lichens of the Island are described in terms of ecology, as influenced by soil and exposure; the purely marine forms are divided into five zones—the farthest from the sea *Xanthoria parietina*; *Lichen pygmaea* nearest the sea.
Voigtländer-Tetzner, Walter. "Beobachtungen über die Dauer des Wachstums der Cladonien an den Gaazfichten bei Arnswalde in der Neumark." *Hedwigia*, LXXII (1932), 144–7.
Volk, Otto Heinrich. "Beiträge zur Ökologie der Sandvegetation der oberrheinischen Tiefebene." *Zeitschr. Bot.* XXIV (1931), 81–184, 21 figs.
Lichens—mainly Cladoniae—are abundant in some of the "Associations."
Vrang, Erik P. "Lichenes Insulae Torsö." *Svensk Bot. Tidskr.* XXV (1931), 174–84.
An enumeration of lichens collected on the Island of Torsö, in Lake Wenner, West Gothland. Notes are given of the types of rock, etc., and of species of particular interest.
Watson, W. "The Bryophytes and Lichens of Moorland." *Journ. Ecology*, XX (1932), 284–313, 3 figs.
Lichens were most abundant in a Heath Association and on Heather Moors, but they occurred in most of the Moorlands described.
—— "Lichenological Notes. V." *Journ. Bot.* LXVIII (1930), 265–70.
—— "Lichenological Notes. VI." *Op. cit.* LXX (1932), 67–72, 96–100.
Werner, R. G. "Contribution à la Flore Cryptogamique du Maroc." Fascicule I. *Bull. Soc. Sci. Nat. Maroc*, X (1930), 98–105.
An enumeration of 90 species of lichens of Morocco.
—— Fascicule II. *Bull. Soc. Hist. Nat. Afr. Nord*, XXII (1931), 93–102, 2 figs.
The series is continued, Nos. 92–171.
—— Fascicule III. *Bull. Soc. Sci. Nat. Maroc*, X (1931), 217–26.
A further contribution down to No. 262. Three fungi are included.
—— "Nouvelle Contribution à la Flore Cryptogamique de l'Alsace. La Parasymbiose." *Bull. Ass. Philom. Alsace et Lorraine*, VII (1928–9), 245–57, 1 text-fig.
—— "Adaptation spéciale des Lichens au Parasitisme." *Compt. Rend. Congrès Soc. Sav. 1928*, 5 pp. (1931).
—— "Sur la Formation des Lichens." *Compt. Rend. Acad. Sci.* CXCI (1930), 1361–2.
—— "Étude comparative de la Germination des spores de Lichens." *Bull. Soc. Mycol. France*, XLVI (1930), 199–206, 1 pl.
—— "Aperçu floristique sur les Lichens du Maroc." *Recueil de Travaux Cryptogamiques dédiés à Louis Mangin* (1931), pp. 135–41.
—— "Histoire de la Synthèse lichénique." *Mém. Soc. Sci. Nat. Maroc*, XXVII (1931), 1–44, 5 pls.
Witte, Hernfrid. "Om vegetationen på ön Städsholmen i Västerviks skärgärd." *Bot. Not.* (1930), pp. 13–34, 1 map, 3 figs.
A considerable number of lichens are included in the survey of islands off the coast of S.E. Sweden.
Zahlbruckner, Alex. "A new *Haematomma* from Florida." *Bryologist*, XXXIII (1930), 31.
The species collected by S. Rapp on *Quercus* is distinguished by the minute apothecia; the spores are 26–29μ × 1·5μ and indistinctly pluri-septate.
—— "Neue Flechten. X." *Ann. Mycol.* XXIX (1931), 75–86.
Diagnoses of new lichen species (Nos. 143–69) from various Eastern countries—Japan, Borneo, Singapore, etc., and from tropical and South America.

ZAHLBRUCKNER, ALEX. "Lichenes. Bot. Ergeb. Deutsch. Zentralasien-Exp. 1927–28." *Mitt. Bot. Mus. Univ. Zürich*, CXLIII (1931), 23–5, edited by Walter Bosshard.
A record of lichens from several localities in Tibet.
—— "Neue Flechten. XI." *Ann. Mycol.* XXX (1931), 427–41.
Nineteen species have been described from different parts of the world. There is one new genus, *Chaudhuria*, from N. India.
—— "Bot. Ergeb. Deutsch. Zentralasien-Exp. Lichenes." *Rep. Spec. nov. reg. veg.* XXXI (1932), 23–5.
Several new or rare species are included. All are from Tibet.
—— "Flechten der Insel Formosa." *Rep. Spec. nov. reg. veg.* XXXI (1933), 194–224.
A first instalment of a lichen flora of Formosa.
—— *Symbolae Sinicae. Botanisch. Ergebn. der Exped. der Akad. Wissensch. Wien, nach Südwest-China*, 1914/1918. Heinrich Handel-Mazzetti. III. Lichenes, pp. 1–254, 1 pl., 1 text-fig. (1930). Verlag von Julius Springer, Wien.
—— *Catalogus lichenum universalis*, VII (1931), 641–784.
—— Supplementum VIII. Addenda et corrigenda (1932), pp. 1–612.

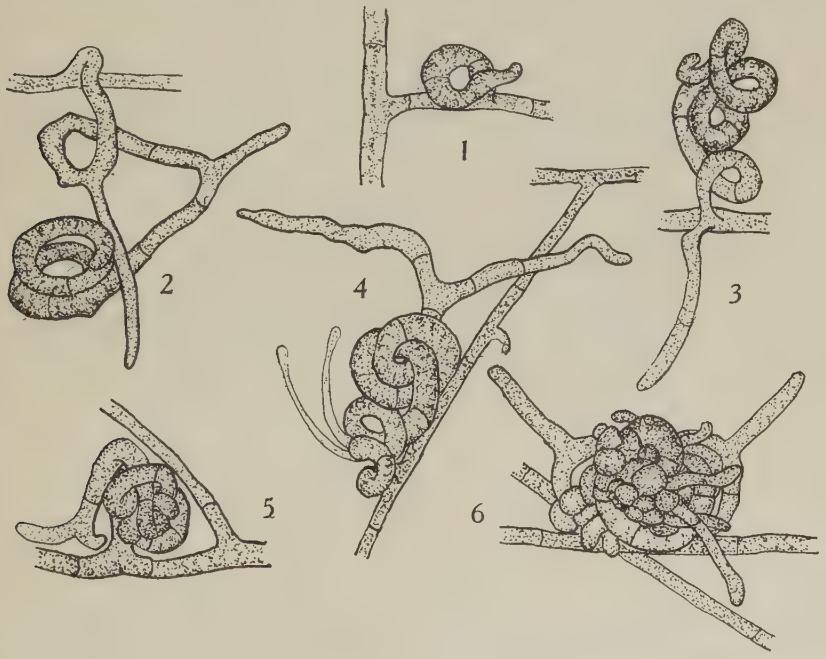
NOTES ON THE ASCOBOLACEAE

By H. C. I. GWYNNE-VAUGHAN and H. S. WILLIAMSON

(With 20 Text-figures)

A. Notes on the origin of the fructification

Among members of the Pezizales a wide diversity has been observed in the structure of the sexual apparatus, and every stage of apogamy has been recorded, normal syngamy being comparatively rare. In order that a true picture may be obtained of the morphology of the



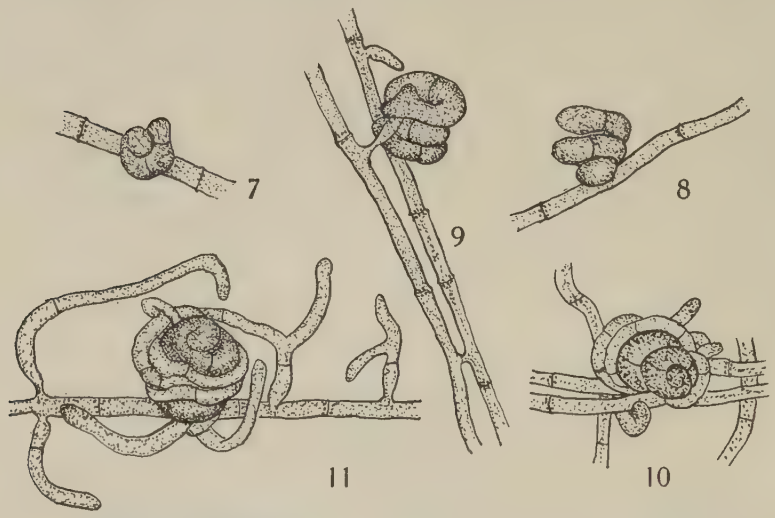
Figs. 1–6. *Ascobolus viridulus*, stages in the development of the fertile branch and sheath of the ascocarp. ×500.

group, the study of additional examples is therefore much to be desired. During the past year, in the search for forms with functional antheridia, we have grown a number of species in culture and have made a preliminary examination of their development. It seems convenient that the information thus obtained, even though incomplete, should be placed on record. In all the species in question the cells are multinucleate, both in the vegetative hyphae and in the

fertile branch or archicarp. As it happened, all proved to be homothallic and in none could any sign of an antheridium be discovered.

(i) *Ascobolus viridulus* Phill. & Plowr. was obtained in a culture inoculated with soil from Windsor Park and, later, on sheep and cow dung sent to us from Aberystwyth. Ascospores germinated readily at 18–25° C. Accessory spores were not observed.

The ascocarp originates from a single, septate hypha (Fig. 1) which becomes elaborately entwined (Figs. 3, 4), the free end often pushing through the loop of the older coils. The distal region may be dichotomously branched (Figs. 4, 5) and recalls the branching trichogyne of *Lachnea cretea* (1). Hyphae grow out laterally from the intercalary



Figs. 7–11. *Ascobolus Leveillei*, stages in the development of the fertile branch and sheath of the ascocarp. A mycelial fusion may be seen in Fig. 9. ×500.

cells of the stalk (Fig. 2) and may be seen protruding from the young fructification (Fig. 6). Branching of this type is very common among Ascomycetes; it is characteristic of the ascogenous hyphae (4) and has been found in the development of the hairs of species of *Lachnea* (5).

(ii) *Ascobolus Leveillei* Boud. was found on sheep dung from Yorkshire and also from Dalhem in Germany. The purple ascospores failed to develop at laboratory temperatures without preliminary treatment, but, after three or four hours at 48° C., they germinated freely at 25° C. In the resulting mycelium hyphal fusions are often found.

The early stages in the development of the fructification are similar to those in *A. viridulus*, but the fertile hypha forms a simple, close twist (Figs. 7–9), the free end of which does not push through the

loops already formed. The distal cell may sometimes fork (Fig. 9), though long branches, as in Fig. 4, were not observed. The sheath is made up of slender hyphae and these are derived from neighbouring filaments rather than from the proximal cells of the fertile branch (Figs. 10, 11) around which they are closely wrapped. Some of them (Fig. 9) appear at a very early stage.

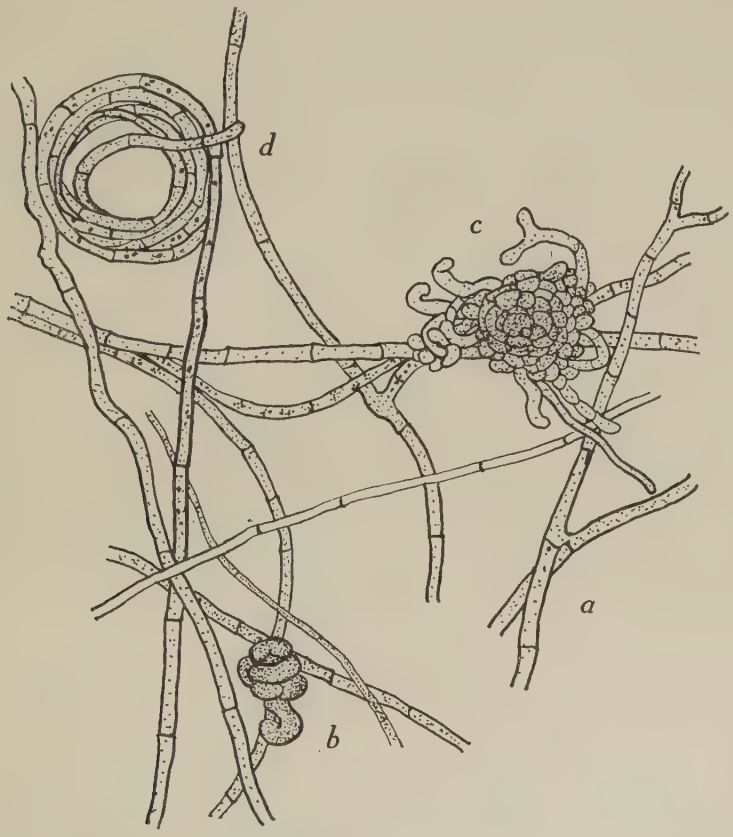


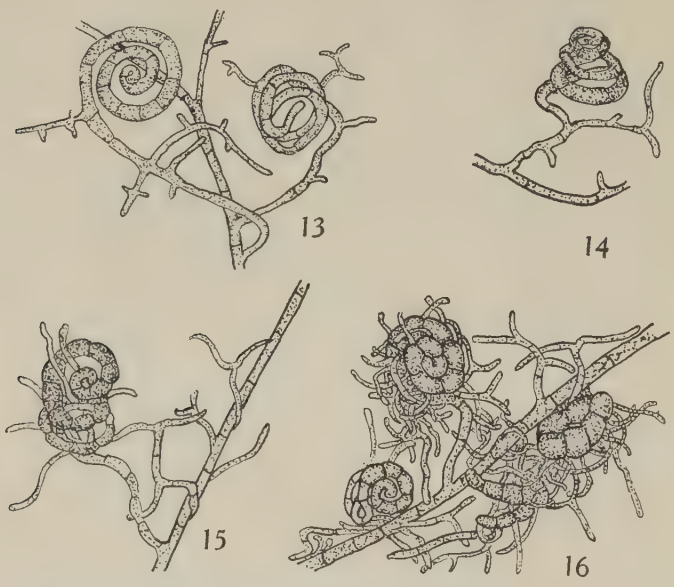
Fig. 12. *Ascobolus equinus*, mycelial fusion at *a*, fertile branch at *b*, young ascocarp at *c*, and coiled hypha at *d*. ×500.

(iii) *Ascobolus equinus* (Mull.) Mass. was isolated from sheep pellets collected in Cumberland in July, 1932. The spores did not germinate in the cold, but, after three or four hours at 48° C., they gave rise at 25° C. to abundant mycelium, among the hyphae of which fusions (Fig. 12 *a*) were not uncommon.

The primordium of the fruit is a closely coiled, septate hypha (Fig. 12 *b*) which is soon enclosed by a sheath (Fig. 12 *c*). Filaments

twisted like a flat coil of rope (Fig. 12 *d*) are of frequent occurrence in this fungus but appear to play no part in development.

(iv) *Saccobolus depauperatus* (Berk. & Br.) Phill. was present, like *Ascobolus equinus*, on sheep pellets from Cumberland. Spores germinated at 25° C. after being subjected for three or four hours to a temperature of 48° C. Those two months old produced a mycelium in seven days, but for younger spores the period, as in *Lachnea cretea* (2), was considerably extended. Owing to the fact that, in this genus, the eight spores of an ascus are liberated together enclosed in a sac,



Figs. 13–16. *Saccobolus depauperatus*, stages in the development of the fertile branch and sheath of the ascocarp. ×500.

single spores are difficult to isolate. One member of a group, however, sometimes germinates sooner than its neighbours, so that the tip of the single germ tube can be cut off and transferred to another plate. In this way seven monothallic cultures were obtained. All gave rise to fruits ten days after inoculation.

The fertile branch is smaller than in the species of *Ascobolus* described above and forms a simple, rather open coil (Figs. 13, 14) from the lower part of which delicate branches arise (Figs. 15, 16) and take part in the formation of the sheath. As the fertile branches are often grouped together (Figs. 13, 16), more than one may be concerned in the formation of a single ascocarp.

B. Notes on the coloration of the spores

The ascospores of *Ascobolus*, *Dasyobolus* and *Saccobolus* are violet in colour, becoming brown when old, and show characteristic markings. In some of our cultures, however, though fruits were formed and viable spores produced, the walls of the latter remained smooth and colourless and they germinated more quickly than normal spores, sending out germ tubes while still in the ascus or while lying in masses on the lid of the Petri dish. This condition appeared to be associated with the presence in the medium of ammonium compounds and a series of experiments was accordingly initiated with such purple spored forms as happened to be available. Some of these do not fruit on synthetic media, so sheep-dung agar was used as the control medium, 0·2 per cent. of various nitrogenous compounds being added.

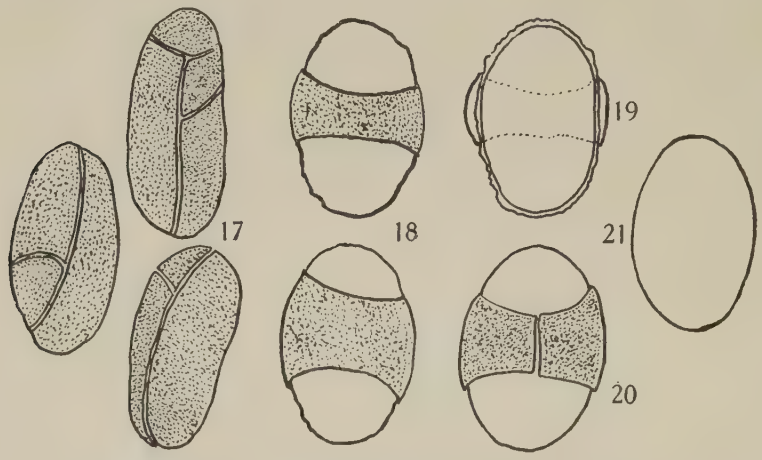
Ascobolus viridulus, grown on unmodified sheep-dung agar, fruited in six days, producing purple spores with longitudinal lines. On sheep-dung agar with 0·2 per cent. ammonium sulphate the time of fruiting was not altered, but the ascospores were smooth and colourless; they germinated readily, giving rise, on control media, to ascocarps with purple spores. Meanwhile, about a month after inoculation, the original cultures were still producing fructifications and in these the spores were now of the usual type with purple, striated coats; presumably the excess of ammonium sulphate had by this time been absorbed or altered. The addition to the agar of 0·2 per cent. ammonium chloride produced the same effect as the addition of ammonium sulphate, but with ammonium phosphate, nitrate, molybdate or tartrate, normal coloured spores were formed.

In the case of *A. Leveillei* fruits appeared on sheep-dung agar five days after inoculation, the purple spores are verrucose and are surrounded by a halo or "ghost" of mucilage; they germinate only after being exposed to an increase of temperature. On sheep-dung agar with 0·2 per cent. of ammonium sulphate, chloride, nitrate or tartrate, the spores were colourless and smooth, lacking a mucilage ghost. They germinated immediately without the application of heat. Spores of this type continued to be formed even after a culture had been fruiting for six weeks. With 0·2 per cent. ammonium phosphate or molybdate, however, though most of the spores were colourless, a few were faintly coloured and showed the verrucose markings and the characteristic "ghost."

A. furfuraceus on sheep-dung agar fruited in eighteen days, on dung agar with 0·2 per cent. ammonium sulphate fruits were formed but did not reach maturity, while in the presence of other ammonium compounds the mycelium gave rise only to oidia.

Dasyobolus immersus grew readily on sheep-dung agar, fruiting in

seven days and producing the characteristic purple spores with scanty markings (Fig. 17). These spores could not be induced to germinate at once, but six months after their formation they gave rise to mycelia when exposed for three or four hours to a temperature of 48° C. followed by 25° C. In the presence of ammonium compounds fruits appeared as quickly as on unaltered dung agar, but on dung agar with 0·2 per cent. ammonium sulphate, though most of the spores were colourless (Fig. 21), some were of the usual coloured type, and some showed a median coloured band (Figs. 18–20) which projected beyond the inner wall. The colourless spores germinated at once, some of them on the lid of the Petri dish without treatment



Figs. 17–21. *Dasyobolus immersus*, normal, purple spores are shown in Fig. 17, spores with a purple band in Figs. 18, 19, 20, and a colourless spore in Fig. 21. The spore in Fig. 19 is seen in optical section, showing the greater thickness of the coloured band. ×400.

of any kind. 0·2 per cent. ammonium chloride had the same effect as ammonium sulphate; in the presence of 0·2 per cent. ammonium phosphate most of the spores were coloured or showed a coloured band, but with 0·2 per cent. ammonium nitrate, molybdate or tartrate most of the spores were smooth and colourless, fully or partly coloured spores being comparatively rare.

With a view to ascertaining whether excess of other nitrogenous compounds produced similar changes all four species were also grown on sheep-dung agar with 0·2 per cent. urea. Excess of urea had a definitely harmful effect. *Ascobolus Leveillei* gave rise to fruits which did not mature, *A. viridulus* and *Dasyobolus immersus* formed no fruits at all, and *Ascobolus furfuraceus* failed to grow. In the presence of potassium nitrate *A. furfuraceus* produced oidia only, but the other

three species fruited as readily as on unmodified sheep-dung agar and gave rise to normal spores.

Owing to the difficulty of obtaining germination in *Saccobolus depauperatus* experiments with this species were not carried out.

An interval is not uncommon in discomycetous fungi between the liberation of the ascospores and their germination. It has been noted in *Lachnea cretea* (2) and *Humaria granulata* (3) as well as in other species. These fungi are now being grown on agar with ammonium compounds in the hope that spores capable of immediate germination may be obtained.

This investigation, like others which preceded it, has been greatly facilitated by a grant from the Department of Scientific and Industrial Research for which we are glad to have an opportunity of expressing our appreciation. It is also a pleasure to thank the authorities of the Department of Botany, British Museum, for identifying the species examined, and Mrs Baines, Miss Wilson, Miss Hobbs and Miss Hubbard for their kindness in sending us material.

Table I

Culture medium	*Ascobolus viridulus*	*Ascobolus Leveillei*	*Ascobolus furfuraceus*	*Dasyobolus immersus*
Sheep-dung agar	Fruited in 6 days, coloured spores, germination in the cold	Fruited in 5 days, coloured spores, germination after heat	Fruited in 18 days, coloured spores, germination after heat	Fruited in 7 days, coloured spores, germination after heat when 6 months old
Sheep-dung agar +0·2% ammonium sulphate	Fruited in 6 days, spores colourless, coloured after 1 month	Fruited in 5 days, spores colourless, germinated in the cold	A few immature fruits	Fruited in 7 days, spores coloured and colourless, latter germinated at once in the cold
Sheep-dung agar +0·2% ammonium chloride	As sulphate	As sulphate	Oidia only	As sulphate
Sheep-dung agar +0·2% ammonium phosphate	As control	Fruited in 5 days, spores colourless or faintly coloured	As chloride	Fruited in 7 days, spores mostly coloured or banded
Sheep-dung agar +0·2% ammonium nitrate	As sulphate	As sulphate	As chloride	Fruited in 7 days, spores mostly colourless
Sheep-dung agar +0·2% ammonium molybdate	As control	As phosphate	As chloride	As nitrate
Sheep-dung agar +0·2% ammonium tartrate	As control	As sulphate	As chloride	As nitrate
Sheep-dung agar +0·2% urea	No fruits	Scanty, immature fruits	No growth	No fruits
Sheep-dung agar +0·2% potassium nitrate	As control	As control	As chloride	As control

SUMMARY

1. The growth in culture and initiation of the fruit are described for *Ascobolus viridulus*, *A. Leveillei*, *A. equinus* and *Saccobolus depauperatus*.

2. The above-named species of *Ascobolus* and also *A. furfuraceus* and *Dasyobolus immersus* were cultivated in the presence of ammonium compounds. Colourless and partly coloured spores were produced: the former were found to germinate more readily than the normal, purple spores.

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(3) —— —— "Contributions to the study of *Humaria granulata* Quél." *Ann. Bot.* XLIV (1930), 127.
(4) —— —— "Contributions to the study of *Pyronema confluens*." *Ann. Bot.* XLV (1931), 355.
(5) —— —— "The ascocarp of *Lachnea scutellata*." *Ann. Bot.* XLVII (1933).

THE FOUNDATION SPECIES OF *ALTERNARIA* AND *MACROSPORIUM*

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(With Plates VI–VIII and 6 Text-figures)

The delimitation of genera in the Phaeodictyae is one of many problems requiring attention. In particular the genera *Alternaria* and *Macrosporium* need to be clearly defined, for both names are used almost indiscriminately for manifestly congeneric species. The name *Alternaria* has come into vogue as the result of the work of Elliott (15), followed by that of Bolle (5) and Mason (22), but Angell (1) has recently given good reasons for his preference for *Macrosporium*, which name, however, Bolle would use in an entirely different sense. It is very desirable to agree on the use of these generic names, and it is proposed to examine critically the grounds on which the use of either is justified.

It will probably be generally admitted that the existing confusion has arisen because the species on which the genera were founded were not clearly established. To form any sound judgment on the scope of a genus, it is necessary to know the species on which it is erected, for, if the conception of a genus is based on the later described species, the original species may not be included in it. The current views of a genus must be subordinated to those on which the genus was originally based. The foundation species of both *Alternaria* and *Macrosporium* have therefore been studied afresh and the results obtained are recorded below. It will be seen that both genera appear to be based on material belonging to the same genus, viz. *Alternaria* as now generally used.

Alternaria Nees

Alternaria tenuis Nees

The genus *Alternaria* was founded by Nees in 1817 on the single species *A. tenuis*. Fries did not recognise the genus in his *Systema Mycologicum*, 1832, but cited Nees's species as a synonym of *Torula alternata*. The original diagnosis given by Nees for the genus *Alternaria* is translated as follows: "Erect, scattered, dark hyphae with separate oval articulations (Glieder) united by filiform connections. Colour blackish green (in the species on which this description is based). Occurs on dead plant stems covering extensive areas. An evanescent, delicate structure which disintegrates and disappears under dry

conditions; the articulations are scattered over the surface as pseudospores, the basal tapering portion of the hypha remaining behind as a short, dark stipe." In his description of *A. tenuis* the significant portion of the diagnosis reads as follows: "Under magnification the slender part of the hypha appeared dark while the articulations, which are exactly the same length as the more slender connections but more than double the diameter, were dull but transparent in the centre; I never saw more than three or four articulations; a thickened articulation appeared to come at the end, for in other hyphae with filiform tips mutilation was observed."

From this description the species cannot be identified with certainty. Nees's figure, which is here reproduced (Pl. VI, fig. 1), shows a chain of two to four conidia with very definite, filiform beaks, and the spore-body "exactly the same length as the more slender connections," thus corresponding with the description. There is no mention of septa in the spore-body, neither is there any indication of them in the figure, but from the general appearance of the conidial chain there can be little doubt that a fungus agreeing with what is commonly accepted as *Alternaria* was intended. Chevallier in 1836 copied a portion of Nees's figure and said the genus differs from *Torula* because the intervals which separate the articulations are very marked and filiform. Corda in 1840 gave an illustration (Pl. VI, fig. 2), which, however, shows a fungus manifestly distinct from that of Nees. The chains comprise up to thirteen spores, the beaks are enlarged at the tip, are not filiform but gradually narrowed from the spore-body, and, in most of the spores, are hyaline in contrast with the dark brown of the spore-body. Corda's figure seems to have influenced mycological opinion greatly, for it is the basis for the modern conception of the species. By the courtesy of Prof. Dr E. Ulbrich a specimen of *Alternaria tenuis* in Mus. Bot. Berol. labelled "Bestimmt von Corda" has been examined. It consists of a fungus with spores of variable shape, the smallest resembling those of *A. tenuis* Elliott, but larger ones, with a much more prominent beak, are also present. It does not resemble Nees's fungus and is not well represented by Corda's figure. Saccardo(30) figured (Pl. VI, fig. 3) the species as a fungus much more like that presented by Corda than the original; the beaks are thick, mostly short, and where they are a little longer they are more sinuous than the straight connections of Nees. Penzig in 1882 (Pl. VI, fig. 4) followed Saccardo more or less closely. Berlese figured *A. tenuis* in 1889 (Pl. VI, fig. 5) and this figure is reproduced in Rabenhorst's *Kryptogamen-Flora* (IX, 262). As Berlese himself noted, he drew the spores with the beaks as basal pedicels, though his correction in the text does not appear to have been generally noticed. The shape of the spore figured approximates to that of Penzig, but the size appears to be somewhat larger and the beaks rather less

prominent. Elliott in 1917 (Pl. VI, fig. 6) represented the spores as tapering but with hardly any definite beaks, not at all comparable with those of Nees (certain of the spores figured are irregular in shape in consequence of secondary growth). Elliott remarks ((15), p. 456) that *A. tenuis* spores cannot be distinguished from those of *A. Dianthi*, but his figure of them is quite different from those of type material of the latter species. Bolle in 1924 (Pl. VI, fig. 7) isolated a fungus from cruciferous and other plants which she identified as *A. tenuis*. Her figures show a fungus with very short beaks, similar to that of Elliott, and an examination of her culture obtained from the Centraalbureau voor Schimmelcultures, Baarn, showed it to bear long chains of spores up to twenty or more. It is evident, therefore, that Bolle's fungus could not possibly be the species from which Nees drew his figure. Clements and Shear(10) in *The Genera of Fungi* have reproduced Saccardo's drawing of *A. tenuis*. The conclusion which appears to be unavoidable from these considerations is that *A. tenuis* Nees does not accord with the prevalent conception of the species.

Macrosporium Fries

The genus *Macrosporium* was founded by Fries in 1832 on four species, viz. *M. Convallariae*, *M. tenuissimum*, *M. Cheiranthi*, and *M. caricinum*.

(1) *Macrosporium Convallariae* (Schumacher) Fr.

The species *M. Convallariae* was described by Schumacher as *Puccinia Convallariae* in 1803 and was transferred to *Macrosporium* by Fries in 1832. There is no type material of the fungus available; I am indebted to Dr C. Christensen for the information that no specimen is to be found in Schumacher's Herbarium in Copenhagen and to Dr Nannfeldt for informing me that there is none in Fries's Herbarium; none exists in Kew Herbarium, and no such exsiccatum is cited by Fries, by Lindau in Rabenhorst's *Kryptogamen-Flora*, or by Ferraris in *Flora Italica*. Exsiccata were published by Thümen in *Mycotheca universalis*, No. 1965, by Roumeguère in *Fungi Gallici exsiccati*, No. 1897, and by Sydow in *Mycotheca Marchica*, No. 1873. Elliott(15) examined the two first named and states that the specimens belong to *Alternaria*, but of the three exsiccata preserved in the British Museum, Thümen's and Sydow's failed to yield any spores, whilst Roumeguère's gave one spore of an *Alternaria* together with a large number of conidiophores and a few spores resembling those of *Heterosporium*. A figure of *Macrosporium Convallariae* was published in the *Icones Plantarum Florae Danicae* in 1839 (Pl. VI, fig. 7), but this figure gives no indication of the genus now known as *Macrosporium*; Dr Christensen states that this figure is copied rather well from a painting made by Schumacher, the original of which is still preserved

in Copenhagen. Bonorden (7) illustrated this species in his *Handbuch* as a typical *Alternaria* spore, with colourless terminal and basal cells (Pl. VI, fig. 8), the figure being quite different from that in the Danish Flora. Two records of *Macrosporium Convallariae* have been made from Italy in recent years, viz. by Rota Rossi (29) in 1907 and by Turconi in 1915, but Prof. Pollacci informs me that material has not been preserved at Pavia. Schumacher's description of the species was as follows: "sparsa, subcongesta, sporulis ovatis subrotundis brevissime stipitatis," and that of Fries: "floccis erectis fugacibus, sporidiis obovatis olivaceo-nigris, septis intermediis saepius 2–3 serialibus, pedicello brevi pellucido." Fries also remarks that the spores "are obovato-clavate becoming black, in water turning olivaceous pellucid, with a short stalk, pellucid, then attenuated below and truncated at the base. Few spores with transverse septa but the greater number only at the base and apex simply septate, but in the middle two or three rows with round loculi." In the diagnosis of *M. Cheiranthi* it is stated that "Ceterum in hoc, ut *M. Convallariae*, subinde vidimus septa media etiam longitudinaliter devisa," and presumably Fries considered longitudinal walls to occur only in these two species. It is probable, therefore, that the latter species, as he conceived it, is congeneric with *Alternaria* though the material available at present does not permit any more definite statement.

(2) *Macrosporium tenuissimum* (Nees) Fr.

The second species mentioned by Fries, *M. tenuissimum*, received originally the name of *Helmisporium tenuissimum* by Kunze *in litt.* (24). The first published name for it was *H. tenuissimum* given by Nees in 1818 with the following diagnosis and notes: "H. laxe caespitosum, fibris erectis simplicibus olivaceo-nigris, sporis ad basin coacervatis ovato-clavatis. Fibrae tenuissime, nudo oculo vix observabiles, maculas formant irregulares unciam et ultra longas, coloris atri in olivaceum tendentis; sub microscopio composito subpellucidae, fuscae, obsolete articulatae. Sporae ratione plantae magnae, 3–4 loculares, pellucidae, septatae, septulis 3 ad 4, densis stratis fibrarum basin obtegunt." The fungus is recorded as occurring on dried stems of Umbelliferous plants collected near Leipzig (Kunze) and near Sickerhausen (Nees). The two figures accompanying this description (Pl. VII, fig. 11) are very small, but a fungus with ovato-clavate or obclavate spores is clearly indicated. Cross-walls are visible but not longitudinal ones. Persoon in 1822 quotes the original diagnosis and Link in 1824 gives the description of Nees with very slight modifications as did also Duby in 1830 who cites an exsiccatum in Desmazières's *Crypt. France*, No. 212.

Fries's diagnosis reads "floccis adscendentibus fugacibus, sporidiis lanceolatis 3–5 septatis pellucidis, pedicello fusiformi." He further

remarks: "A praecedente omnino diversum floccis tenellis, ramosis, undique septatis; haud ita prorsus evanescentibus; sporidiis magis regularibus, clavato-lanceolatis, simpliciter septatis, pedicello longiori graciliori. Habitus insuper longe alius, maculas offerens tenuissimas haud secendentes." From Fries's remark quoted above (p. 138) he apparently considered the species to have no longitudinal walls.

Text-fig. 1. Conidia and conidiophore of *Helmisporium tenerum* Kunze drawn from material preserved in Herb. Fries. under this name. ×500.

Fries gives *Helmisporium tenue* Kunze *in litt.* as a synonym of *Macrosporium tenuissimum*, and Prof. Nannfeldt of Upsala has been good enough to send me a slide from a specimen in Herb. Fries. labelled *Helmisporium tenerum* (sic) Kunze in handwriting which he considers resembles that of Fries in his younger days. He states that the specimen consists of a small piece of an old stem, about 2 cm. long and ½ cm. broad and a few mm. thick, of some large herbaceous plant, the surface of which is blackened by fungus growth. Examination of the slide showed the presence of a profuse growth of conidiophores of the usual *Alternaria* type about 82–115 × 4–5 μ (up to 8 μ in swollen regions) in diameter. There were also present a small number

of *Alternaria* spores (Text-fig. 1) mostly somewhat undeveloped, with a pointed apex constituting a very short beak; they measure 24–46 × 11–21 μ and the species might accordingly be placed in the *A. tenuis* group sensu Mason.

Fries also cites the exsiccatum of Desmazières, and one of these is in Kew Herbarium. It consisted of petals arranged in four portions; the two upper show olivaceous spots on the whitish petals, while the lower pair consists of darker coloured petals on which the fungus was not clearly discernible macroscopically. Fries states that the fungus occurs on petals of *Dianthus*, *Ranunculus asiaticus*, etc., but no mention of the host is given on Desmazières's specimens, examination of which showed a species of *Heterosporium* to be predominant, but a species of *Alternaria* was also present in each (Text-fig. 2; Pl. VII, fig. 10). A second specimen consisting of a number of petals similar to the dark-coloured ones of the preceding and pasted on similar paper was found labelled: "*H. tenuissimum* No. 212, Herb. Mycol. M. C. Cooke 1885." It is very probably a part of a Desmazières's specimen and contained the same *Heterosporium* and *Alternaria*, though on this specimen the spores of the latter were better developed and more numerous than in that above mentioned. There can be little doubt that the *Alternaria* in these specimens was the fungus intended as *Macrosporium tenuissimum*; the spores of the *Heterosporium* are cylindrical with rounded ends and could not possibly be described as clavate or obclavate.

Prof. Nannfeldt informs me that Desmazières's No. 212 is represented at Upsala and consists of petals bearing similar fungi to those of Kew. The Desmazières fungus, however, is entirely distinct from *Helmisporium tenerum* Kunze ex Herb. Fries., and the question arises which fungus is to be regarded as the authentic one. The original description of Fries clearly indicates a fungus with long slender "pedicello" (= beaks), and this description fits Desmazières's fungus very well while the *H. tenerum* Kunze hardly has any definite beaks at all. There is a discrepancy in the specific name of the Kunze specimen which should be *tenuissimum* according to Nees, while Fries cites it as *tenue* and the specimen is *tenerum*. On the other hand the specimen is on the stem of some large herbaceous plants and would agree in this respect with the original host (dried stems of Umbelliferae), whilst the number of major cross-septa of the conidia observed agrees with the description "3 to 4 locular." Prof. E. Ulbrich has kindly ascertained that no authentic specimen is to be found in Herb. Bot. Berol. or in a special collection of Kunze's Fungi exsiccati preserved at Berlin. Considering all the evidence available, it appears legitimate to regard Desmazières's specimen No. 212 as representing the species which Fries had in mind in making his new combination though there is some doubt whether actually he had the correct

fungus. In the absence of indisputable evidence of the authenticity of the Kunze specimen, and as mycological nomenclature dates from Fries, I suggest that Desmazières's exsiccatum should be adopted as representing the species, which as will be seen later (p. 157) is transferred to *Alternaria*. The fact that the original description did not contain any reference to longitudinal walls may be interpreted as an omission on the part of Nees (if the specimen of Kunze's in Herb.

Text-fig. 2. Conidia and conidiophores of *Helminthosporium tenuissimum* Nees from Desmazières's *Crypt. France*, No. 212. ×500.

Fries. is authentic this must be so), and Fries failed to remedy this omission though longitudinal walls were present in Kunze's specimen and in the Desmazières exsiccatum cited by him. So far no fungus has been collected corresponding exactly to the latter, but should it be encountered there is little doubt that it would be recognisable again; sufficient material in the exsiccatum is available to form a good basis of comparison. It is rather a characteristic species and it would be regrettable to lose it altogether.

It may be mentioned that Saccardo transferred *Macrosporium*

tenuissimum to the genus *Clasterosporium* in 1904, apparently on the ground of the absence of longitudinal walls in the diagnosis. The figure of the fungus he takes to be *C. tenuissimum* roughly corresponds with Desmazières's fungus in the shape of the conidia, but it has no longitudinal walls and is quite different from the type material of the species; neither is it congeneric with *C. caricinum* Schweinitz, the species on which the genus was founded and which is referred to below. Elliott(15) agrees with Saccardo in regarding *Macrosporium tenuissimum* as having no longitudinal walls, but nevertheless would make it the type species of *Macrosporium*, with which he considers *Clasterosporium* to be synonymous. Bolle(5) would put *Macrosporium tenuissimum* into *Sporodesmium* established by Link in 1809, as the majority of the species of this genus described by Fries have only transverse septa, but such transference could only be justified if longitudinal walls were lacking.

(3) *Macrosporium Cheiranthi* (Libert) Fr.

The third species, *M. Cheiranthi*, was first named *Helminthosporium Cheiranthi* by Libert, who issued an exsiccatum of the fungus in 1827 (Desmazières, *Crypt. France Exsicc.* No. 213). Fries transferred the fungus to *Macrosporium* as *M. Cheiranthi* in 1832, and cites Libert's exsiccatum which is of course the type of the species. The following description of the fungus was issued with the exsiccatum: "Floccis ramosis griseis pellucidis septatis fugacibus; sporidiis crebris magnis pyriformibus substipitatis nigris; septis 5–7." One of Libert's specimens is in Kew Herbarium. It consists of four wallflower leaves with spots about 1 cm. in diameter and bearing a black fungus. Scrapings from this material showed spores with rather irregular shape, mostly with a definite apex, which was usually rather blunt, though tapering; some of the smaller spores were roughly spherical and some were elongated cylindrical with rounded ends (Text-fig. 3). All were multiseptate, the largest containing a very large number of cells; the oldest septa were frequently recognisable and the original cells had evidently subdivided a number of times. A very young spore was seen to be one-celled and pyriform and borne singly on a simple conidiophore. The basal scar was usually plainly visible, and one spore also had a definite apical scar showing that a chain of at least two spores must have occurred. The conidia, in lactic acid, were light brown and translucent, so that the walls of cells below the surface could be distinguished, the cell walls themselves being dark and clearly defined; they measured 21–97 × 13–32 μ, average 54 × 20 μ, and their surface was smooth but sometimes with a granular appearance in surface view. The conidiophores were mostly simple, brownish (old material), about 5–8 μ in diameter, septate with individual cells about 8–15 μ long, and rounded at the apex, which was marked by

a single terminal scar but not swollen; a lateral scar was sometimes visible as well. The mycelium was not very even in diameter as some cells were rather swollen.

In May, 1930, this fungus was observed on wallflowers (*Cheiranthus Cheiri*) growing at Oakley, Hants. The affected plants bore numerous spots on the leaves on which the blackish mass of spores and mycelium of the fungus were clearly seen, especially towards the centre (Pl. VII,

Text-fig. 3. *Helminthosporium Cheiranthi* Libert—drawn from Desmazières, *Crypt. France Exs.* No. 213. ×500.

fig. 12). The spots were fairly numerous, but the disease did not do sufficient damage to the plants to be noticeable to the casual observer. One day after a frost, a number of leaves were clearly injured, and a few days later the growth of *Macrosporium Cheiranthi* was visible on most of the damaged areas. The fungus here was doubtless secondary, and later on when the flower stalks were dying back, they became covered with the fungus mixed with *Cladosporium herbarum* which could be distinguished macroscopically by its lighter green. In September, 1932, *Macrosporium Cheiranthi* was again found in the same locality on wallflowers, but it was practically confined to the drying seed pods

on which it formed extensive black, powdery areas and only an occasional spot occurred on the leaves. From the manner in which the disease developed the fungus is possibly nothing more than a somewhat feeble parasite which may also develop freely on dead wallflower material.

Microscopically the fungus exactly tallied with Libert's specimen and there could be no reasonable doubt about their identity (Text-figs. 4 and 5; Pls. VII and VIII, figs. 13, 14). On the leaf, the

Text-fig. 4. *Macrosporium Cheiranthi* (Lib.) Fr. drawn from material collected at Oakley, Hants, in 1930 and 1932. ×500.

conidiophores develop in vast numbers over the infected spot but especially towards the centre. They are formed singly at first; hyphae from the hyaline mycelium visible in the tissues of the leaf penetrate the epidermis and continue growth to form the somewhat irregularly bent conidiophores which measure from 5 to 8 μ in diameter and vary in length, in different spots, from 77 to 126 μ. Sometimes a spherical swelling (up to 13 μ in diameter) is seen at the base of the conidiophore. Branching may take place, usually close to the surface of the host and fresh conidiophores arise producing a dense growth

in which large clusters comprising as many as thirty or more may be recognised. In colour the conidiophores are light olive, sometimes almost hyaline at the tip. Cross-walls occur at intervals of about 8–15 μ. A single terminal scar is found in young conidiophores, but in old ones as many as four scars have been observed, lateral ones being recognisable at irregular distances from the tip, two scars often occurring in the same cell.

The conidia measure 27–87 × 14–28 μ (25 spores) and agree with those of Libert's specimen completely. The number of main cross-walls varies from three to ten but is mostly nine; the principal cross-walls are recognisable by the constriction of the spore, except in the region of the beak. They are borne singly for the most part, but short chains of two or three conidia were sometimes seen. The number of conidia with apical scars was roughly about 15 per cent., indicating that, if the catenulate conidia were in chains of two, about 17 per cent. of the conidiophores bore chains. The young, vigorously developing conidia (Pl. VII, fig. 13) are generally more regularly shaped, with gradually tapering apex, than the older ones (Pl. VIII, fig. 14), which are subject to secondary growth, and this may develop so far that individual conidia are seen sometimes apparently breaking up into irregularly shaped conglomerations of cells (Pl. VIII, fig. 15). Externally the conidia are mostly smooth, but, as in the type material, a granulation is often discernible in surface view especially in spores not yet fully coloured. The appearance of the wall in optical section suggests that this granulation may be due to the pitting of the wall on the interior. Occasional spores are also seen bearing scattered warts on the outside, usually very small, but sometimes reaching quite considerable dimensions.

In culture the fungus produces on clear maize-meal agar a colony about 4 cm. in diameter within six days. Such a colony has a deep olive tint (Ridgway) except at the margins which are whitish, and produces a fairly well-developed aerial mycelium giving the surface the appearance of a soft woolly cloth. The conidia (Text-fig. 5) are borne singly at first, or occasionally in twos, on aerial branches and not near the agar. The conidiophores are usually simple but may be branched, each branch bearing a conidium. They are slightly thicker than the ordinary mycelium and dark coloured. Later the colour of the colony becomes approximately greyish olive, but the growth remains somewhat sparse and is transparent enough for writing to be read easily through it. Catenulation of the conidia becomes more prevalent in older cultures, but the chains are short, mostly of two or three. There are some slight indications of zonation. The submerged mycelium is coloured, and between the colonies a line marking their junction is sometimes discernible. Under the microscope this line, which measures about 2 mm. across, is seen to be associated with

increased sporulation, the conidia being borne in chains of two to five (Pl. VIII, fig. 16). Sometimes the chains are branched, but the branches are short and consist of one or two secondary conidia borne on a primary one.

On potato-dextrose agar, the fungus grows freely, a diameter of 8·7 cm. in eleven days at 20° C. (5·9 cm. in eight days) being recorded. In the centre of such a colony a whitish, raised, floccose area about 1 cm. diameter may be seen. Surrounding this, the growth is dusky

Text-fig. 5. *Macrosporium Cheiranthi* (Lib.) Fr. drawn from a culture on clear maize-meal agar. × 500.

olive-green on the surface with olivaceous black tints below. Towards the edge the colony becomes yellowish but never whitish. On the reverse the colony is olivaceous black in the centre, shading towards the periphery, the density of colour is patchy with some indications of zonation. Examined microscopically, the conidia are mostly irregularly oblong and borne singly or in short chains of two or three on coloured conidiophores which are frequently encrusted, though the spores themselves appear smooth. When the spores occur in chains the beaks are not so tapering and the isthmus is well marked off from the spore-body.

On Dox agar, growth is not so vigorous, reaching a diameter of 5·5 cm. in eleven days. The colour of the colony is not uniform; the centre frequently produces white tufts of mycelium and is surrounded by a dark olive zone beyond which the growth is much lighter in colour, yellowish, and becoming almost hyaline at the extreme edge. The hyaline, aerial mycelium is much more freely developed than on the preceding media. The characteristic feature of the growth is the formation of appressoria which develop in large numbers in contact with the glass and can be recognised as small dark dots visible to the naked eye. The spores are borne mostly on short chains of two or three.

On bean agar a profuse dark-coloured growth is obtained, and one Petri dish culture produced an albino saltant with spores exactly agreeing with the parent species but without colour; when cultured separately the saltant gave a pinkish white growth.

Macrosporium Cheiranthi has often been recorded, and it may be as well to consider these records to find out how far the general conception of the species is trustworthy. Of the exsiccata in Herb. Kew., the following were found to be correctly determined: J. E. Vize, *Micro-fungi Britannici*, No. 138, on *Cheiranthus Cheiri*; Briosi and Cavara, *I funghi parassiti delle piante coltivate od utile*, No. 421, on *C. Cheiri*; specimen from Herbier du Jardin bot. de Bruxelles, *Helminthosporium Cheiranthi* on *Cheiranthus Cheiri*; a specimen on pods of *Cheiranthus* in Herb. Berk.; and an unnamed specimen on *Cheiranthus* stem from Herb. Berk. in the *Macrosporium Cheiranthi* folder in Herb. Kew. M. C. Cooke's specimen of *M. Cheiranthi* on *Ficus* collected by Aitken in South Carolina is not this species; the spores are too small and are provided with distinct and more pointed beaks. A specimen labelled *Macrosporium Cheiranthi* and *M. obtusum* Berk. on maize, No. 287 in Herb. Berk., collected in Kingston in 1845, yielded no conidia of *M. Cheiranthi*. Ravenel's *Fungi Carol. Exsicc.* No. 89 on dying spinach leaves is rather like *M. Cheiranthi*, but the spore beaks are too pointed and too long. A specimen on *Cucurbita lagenaria*, No. 1055 in Herb. Berk., collected at Santee River is not *Macrosporium Cheiranthi*, but resembles a large-spore member of *Alternaria tenuis* group sensu Mason. An exsiccatum from Herb. Berk., No. 357, of *Macrosporium Cheiranthi* on *Abutilon Avicennae* has spores that are too pointed and have beaks too long for this species. Of all the specimens examined in Herb. Kew., none appears to be correctly named except those on *Cheiranthus*, and the records of the species on any other host need confirmation.

Bolle (5) provisionally identified an *Alternaria* found by her on the leaves of beets and many other plants with *Macrosporium Cheiranthi* (Pl. VIII, fig. 17) on the ground that it agreed with the *Alternaria* constituting the bulk of Rabenhorst's *Fungi Europaei*, No. 1360, labelled *Macrosporium commune* Rabh. type *M. Cheiranthi* Fr. This is part of the same material as Cooke's *Fungi Brit. Exsicc.* No. 197 and

cannot be regarded as authentic for *M. Cheiranthi*. Rabenhorst's No. 1360 contains very few spores, but there are two specimens of Cooke's No. 197 in Herb. Kew. and these contain various fungi, including *M. sarcinula* and a *Heterosporium*, but a rather long-beaked, large-spored *Alternaria* is predominant, at least in parts, and this species is presumably the one which Bolle took to be *Macrosporium Cheiranthi* (Pl. VIII, fig. 18). She was under the impression that there was no exsiccatum of Fries for *M. Cheiranthi* and did not appear to know of Libert's specimen. She transferred *M. Cheiranthi* to *Alternaria* as *A. Cheiranthi*, but her figures agree with Cooke's fungus and not with Libert's. The number of cells in a spore in Bolle's figure is fourteen to seventeen, whereas in the figure of Libert's specimen they range up to forty. A culture of her fungus obtained from the Centraal-bureau remained sterile, but Prof. Westerdijk is of opinion that Bolle's fungus differed from that of Libert.

A feature of *Macrosporium Cheiranthi* is its reluctance to form chains. The impression I obtained on examining the fungus in culture for the first time was that it was more like a *Stemphylium* than anything else, but it does not really belong to this genus, for firstly the spores, generally, taper towards the apex and in a fairly young vigorous growth the shape is definitely pointed and regular, and secondly short chains occur in nature and develop fairly generally in mature cultures, especially along the line of junction of two adjacent colonies.

(4) *Macrosporium caricinum* Fr.

The fourth species mentioned by Fries, viz. *M. caricinum*, was described from a specimen sent by von Schweinitz from America. The latter author erected the genus *Clasterisporium* on the single species *C. caricinum* in 1834, accompanying his description with four figures. In Herb. Kew. is a specimen in Berkeley's herbarium labelled: "*Clasterisporium caricinum*, L. v. S., Bethlehem. Herb. Schweinitz." This is no doubt one of Schweinitz's specimens and constitutes co-type material of *C. caricinum*. On it a few spores were found corresponding exactly with the original figures of the fungus and also with the following exsiccata in Herb. Kew.: Ellis, *North Amer. Fungi*, No. 126, on *Carex*, published 1878; *Fungi New Jersey*, No. 2, on *Carex*; Rabenhorst-Winter, *Fungi Europaei*, No. 2882, on *Carex* (this specimen was collected by J. B. Ellis, Newfield, New Jersey); and one from Herb. Cooke, labelled: "*C. caricinum* Schw. New Baltimore, N.Y. E. C. Howe legit. C. H. P." The fungus forms large curved spores, dark coloured, with transverse walls only, obtuse apex, and attached by a slightly attenuated base (Text-fig. 6). The spores break off either by the fracture of the wall or separate at the cross-wall, leaving a short branch with a large scar showing the point of attachment. The pedicel is light coloured like the mycelium and often

sharply marked off from the darker cells above; the spore is also inclined to become almost hyaline towards the tip. Hyphopodia are present on the superficial mycelium. The fungus is very characteristic and agrees with the description given by Fries in the *Systema.*

There is little doubt that *Macrosporium caricinum* Fries is the same fungus as *Clasterosporium caricinum* Schweinitz and is the type species

Text-fig. 6. *Macrosporium caricinum* Fr. from the exsiccatum Rabenhorst's ***Fungi Europaei***, No. 2882, collected by J. B. Ellis, New Jersey. This specimen agrees with co-type material issued by Schweinitz. ×500.

of *Clasterosporium.* Corda(13) placed *C. caricinum* in *Sporodesmium* as *S. closterisporium*, but Elliott remarks that the genus *Sporodesmium* is so heterogeneous that this disposition cannot be considered final. Bolle regards *Clasterosporium* as a synonym of *Sporodesmium.* The species *Macrosporium caricinum*, however, manifestly does not belong to the Phaeodictyae and therefore need not be considered further in this connection*.

* It may be mentioned that the well-known species *Clasterosporium carpophilum* is clearly not congeneric with *C. caricinum.* The former species was first named

Forms included in the *Alternaria-Macrosporium* group

Having reviewed the evidence of the identity of the foundation species of *Alternaria* and *Macrosporium* it may be convenient to consider the forms included in the *Alternaria-Macrosporium* group as a whole.

From a study of various species in this group, it is evident there are three types of fungi included in it, as Angell (1) has already pointed out:

(*a*) those forming long chains of shortly or comparatively shortly beaked spores;

(*b*) those forming chains only rarely, the spores being provided with long, filiform beaks;

(*c*) those with spores normally borne singly (though occasionally bearing secondary ones on short conidiophores), sarcinaeform, without any beak, usually with a major cross-wall accompanied by a constriction.

The group (*a*) is placed in the genus *Alternaria* by common consent; it includes such species as *A. Citri*, *A. longipes*, *A. tenuis* auct., *A. fasciculata*, and is clearly congeneric with *A. tenuis* Nees. Members of group (*b*) are sometimes placed in *Alternaria* and sometimes in *Macrosporium* as shown by the following species which all belong to this group: *Alternaria macrospora*, a species in which the formation of a second conidium at the end of the extremely long beak would be unbelievable had it not been observed, *A. Solani*, *A. crassa*, *A. Tomato*, which has long been known as *Macrosporium Tomato* but has recently been renamed, *M. Porri*, *M. Ricini*, and *M. Sesami*. Group (*c*) is commonly placed in *Macrosporium*; the typical member of this group

Helminthosporium carpophilum by Léveillé in 1843. Samuel (34) objects to this name on the ground that the spore-bearing hyphae are not specially thickened or in any other way differentiated into conidiophores distinct from the mycelium, but he figures conidiophores very like those of *Helminthosporium*. It is regrettable that the transference to *Clasterosporium* was ever made, though the original name should not be revived unless the fungus is proved properly to belong to *Helminthosporium*. Cooke in 1877 added two species of *Clasterosporium*, viz. *C. maculatum* and *C. vermiculatum*, and as these appeared from the figures to have spores similar to those of *C. caricinum*, type material in Herb. Kew. was examined. Though the spores in both have a general resemblance to *C. caricinum*, they are borne differently and neither fungus has hyphopodia. In *C. maculatum* the conidiophores are short and are grouped in a pustule, in *C. vermiculatum* they appear to arise on dark-coloured, short, somewhat conical conidiophores which may be isolated or grouped. Neither species, therefore, assists in clarifying the genus. Saccardo in 1886 revised the genus *Clasterosporium*, listing first *C. hormiscioides* and *C. Hirudo* Sacc. but including *C. caricinum* (Elliott's statement on p. 470 that Saccardo ignored *C. caricinum* is an error), and von Höhnel (17) considers the first two species are similar in essentials to *Hymenopodium* Corda, which genus he revives for these and congeneric species. Sydow in 1915 erected the genus *Cheiropodium* on the single species *C. flagellatum* on *Carex breviculmis* from Japan, but von Höhnel regarded this genus as synonymous with *Clasterosporium*, and suspected the perfect form of *Clasterosporium* Schweinitz to be a *Meliola*.

is the conidial stage of *Pleospora herbarum* which is usually regarded as being *Macrosporium sarcinula*, and other species belonging here are *M. parasiticum*, *M. sarcinaeforme*, *M. Alliorum*, *M. Sophorae*, *M. Symplocarpi*, *M. nigricantium*, *M. Eriobotryae*, *Stemphylium Solani*, *Macrosporium Camelliae*, and *M. verruculosum*.

Between groups (*a*) and (*b*) there are, of course, intermediates, *e.g.* *Alternaria Brassicae* which has spores with much shorter and much thicker beaks than those typical of group (*b*), borne in short chains, not exceeding five spores in a chain. *A. Sonchi* and *A. Panax* are allied to *A. Brassicae*. Elliott subdivides groups (*a*) and (*b*) into seven groups, indicating the gradations between the two groups (*a*) and (*b*) here cited. Group (*c*) is sharply defined from the rest and forms a homogeneous group by itself.

Generic criteria

In attempting the classification of the forms, it is necessary to consider the criteria to be used for the purpose. The popular distinction between *Alternaria* and *Macrosporium* is that in the former the spores are borne in chains and in the latter singly. Chain formation, as a generic character, has been losing importance in recent years, since it has gradually become apparent that it may be very much suppressed, so that in some species it is only rarely evident at all. Elliott states that all Phaeodictyae with tapering spores are capable of forming chains, and Bolle remarks on the instability of chain formation as a character. Between groups (*a*) and (*b*) there are gradations in chain formation which render it difficult to make this character the absolute basis of generic distinction; though the fact that group (*a*) has spores usually in long chains necessitates that some weight must still be attached to it.

The filiform beak is typical of group (*b*), but again this is very variable. Beaks vary enormously in length and thickness; they may be five times the length of the spore-body or merely represented by a tapering of the spore at the apex; they may be filiform, or thick and squat, stiff or pliable, branched or unbranched. Furthermore the beak of the fungus on the natural host may be very different from that developed in culture, *e.g.* *Alternaria gossypina* (Thüm.) Hopkins (18) on the cotton plant has only a short beak, but in culture this fungus produces quite a long beak which, whilst not so narrow or long as that of the extreme filiform type, is sufficiently like it to be placed in the same category. *A. longipes*, on the other hand, has a short beak on the leaves and practically no beak at all in culture (19, 40). The length of the beak is usually developed fully, but it may also vary considerably in cultures of a single species and occasionally spores are observed with no beak at all even in the long-beaked species. It does not seem practicable, therefore, to place

groups (*a*) and (*b*) in separate genera on account of their beaks alone; all gradations between the two types could probably be obtained if desired.

Echinulation of the spore is typical of all three groups but considerable variation occurs in closely related species; this character is generally regarded as having no value generically.

The conidiophore in groups (*a*) and (*b*) consists of a branch of the mycelium, which may be thickened and of a dark colour, and which bears from one to several conidia in chains. The conidiophore may bear only a single scar, where the terminal spore or spore chain is attached, or several; sometimes the conidiophore continues growth, forcing the originally terminal spore or spore chain into a lateral position. In *A. tenuis* sensu Bolle the spore is frequently elongated into a short isthmus bearing several spores, the scars of which are clearly visible. The scar in both groups (*a*) and (*b*) is formed as a circular darkening with a hyaline centre; they are precisely similar to those of *Stemphylium* (*i.e.* of *S. botryosum* sensu Oudemans). The conidia in group (*c*) are borne differently. The conidiophore is formed as a short branch of the mycelium which is often somewhat thickened, dark in colour, and invariably swollen at the top. After the original terminal spore has matured the conidiophore sometimes continues growth, not laterally, as in groups (*a*) and (*b*), but terminally through the scar, and the successive swellings in an old conidiophore mark the places where spores have been borne. The characters of the conidiophore, therefore, clearly distinguish group (*c*) from groups (*a*) and (*b*), but not the latter from each other.

The shape of the spore varies very much apart from the beaks; in groups (*a*) and (*b*) it invariably tapers towards the apex, even though this may be very blunted; whereas in group (*c*) this tapering is absent, though in *Macrosporium nigricantium* the spore is sometimes shortly pointed at the apex, otherwise it agrees with the general shape of group (*c*).

From this survey it appears that groups (*a*) and (*b*) are very closely allied, whilst group (*c*) is markedly distinct in its conidiophore, its spore shape, and the absence of chain formation. The relation between groups (*a*) and (*b*) is a matter of opinion, but it would be inadvisable to place them in separate genera at present with our limited knowledge of these fungi. The gradations between the two groups are so many that to separate them generically would entail very many difficulties. The modern tendency to place all the members of group (*b*) in *Alternaria* agrees with this interpretation of the two groups, but the fact that recently described new species of this group have been placed in *Macrosporium* indicates that this tendency is not general. The distinguishing character of groups (*a*) and (*b*) is the beaked spore, separating them from all other genera of the Phaeo-

dictyae, but associated with this character is either a marked development of chain formation or of the length and narrowness of the beaks; as the beaks get longer, the spores in the chains become fewer.

The foundation species in relation to forms included in the *Alternaria-Macrosporium* group

The five original species of *Alternaria* and *Macrosporium* may now be considered in relation to the three groups mentioned above. Of the five species only three are significant, viz. *Alternaria tenuis*, *Macrosporium tenuissimum*, and *M. Cheiranthi*, as *M. caricinum* clearly belongs to a different genus (and is in fact the type species of *Clasterosporium*), whilst *M. Convallariae* must be regarded as unknown.

The true *Alternaria tenuis* Nees has spores borne in short chains of four and the spores have filiform beaks, indicating that the species would come midway between groups (*a*) and (*b*), an additional and weighty argument for uniting these two groups in the same genus.

Accepting Desmazières's exsiccatum as authentic for *Macrosporium tenuissimum*, this species must be regarded as congeneric with *Alternaria tenuis* Nees. The spores have definite beaks and were borne in chains. Even if the Kunze specimen is maintained as representative of the species, the conclusion regarding the genus for the species would be the same.

Macrosporium Cheiranthi, though it does not form chains very readily, nor has it a filiform beak, nevertheless is clearly related to the groups (*a*) and (*b*). In the lax tendency to chain formation and the short, indefinite beaks it verges somewhat towards *Stemphylium* (sensu Oudemans) but cannot properly be regarded as belonging to that genus, particularly as the spores are predominantly beaked and not oval.

Alternaria v. Macrosporium as the name for the group (*ab*)

The question arises which are the correct generic names for (i) the congeneric groups (*a*) and (*b*), and (ii) group (*c*) and incidentally the correct usage for the generic names *Alternaria* and *Macrosporium*.

In the first place, it must be noticed that all the foundation species of *Alternaria* and *Macrosporium* belong to the combined group (*ab*) and none to group (*c*). Consequently the name for the former group must be either *Alternaria* or *Macrosporium*, and *Macrosporium* must be discarded for group (*c*).

It must be admitted that as the International Rules of Botanical Nomenclature stand the name *Alternaria* is illegal, as it was not recognised by Fries in his *Systema*, 1832. Further, the species on which the genus was founded has not yet been recognised. On the other hand, the name is widely used, and although the diagnosis of *Alternaria tenuis* is insufficient for the identification of the species, the

genus is clearly indicated. The current conception of the genus *Alternaria* is undoubtedly that of Nees and has been consistently used in this sense.

Macrosporium is the strictly legal name, being described by Fries in the *Systema*. Of the two significant species of the four original ones, *M. tenuissimum* is represented by two exsiccata of different species, of which Desmazières's is rather characteristic and is apparently the fungus Fries had in mind, though it is not certain whether it is the original species of Nees, while *M. Cheiranthi* is definitely identifiable from authentic material and clearly belongs to the group (*ab*). It is possible, therefore, to select *M. tenuissimum* as representing the genus, which would also contain *M. Cheiranthi* and include all the species now known as *Alternaria* as *Macrosporium*.

The great objections against adopting the genus *Macrosporium* for group (*ab*) are (1) that the whole tradition of systematic mycology has been opposed to regarding *Macrosporium* as having spores in chains, (2) that the name has been consistently but erroneously applied to group (*c*) as well as to the (*b*) part of group (*ab*), so that without some further indication the name does not, and will not, convey any clear meaning of the genus implied. The confusion that has surrounded the genus *Macrosporium* affords strong grounds for advocating that it be discarded altogether as a *nomen ambiguum*, a course which is discussed below, though, on the other hand, it may be said that now the mistakes have been brought to light there is no necessity to continue the use of the genus in the wrong sense.

With regard to group (*c*) the use of the genus *Macrosporium* for this group dates from 1838 when Berkeley described *M. sarcinula*. As Bolle(5) has shown, Berkeley included two distinct fungi in this species: (1) a fungus with beaked spores belonging to group (*ab*), and (2) a fungus with sarcinaeform spores now recognised as the conidial stage of *Pleospora herbarum* and belonging to group (*c*). Berkeley himself stated that he was not certain whether both belonged to the same fungus but thought the beaked spores to be the immature stage of the sarcinaeform spores. He did not consider the sarcinaeform typical of *Macrosporium*, however, for he regarded *M. Cheiranthi* (in which he included forms of *Alternaria tenuis* group auct.) as the type of the genus(3), and it is probable he would not have placed *Macrosporium sarcinula* in *Macrosporium* but for the beak-spored fungus present in his material.

The use of *Macrosporium* in this sense was further strengthened by Penzig's(26) drawing of *M. commune* Rabenhorst. As mentioned above (p. 147) this name was given by Rabenhorst (*Fungi Europaei*, No. 1360) to Cooke's collection known as *M. Cheiranthi* Fr. on beet which was issued as *Fungi Brit. Exsicc.* No. 197. Rabenhorst's exsiccatum contained a mixture of two fungi, the *M. Cheiranthi* of Cooke and a fungus

with sarcinaeform spores belonging to group (*c*). Penzig in illustrating *M. commune* from a collection on citrus drew a fungus with sarcinaeform spores, and Saccardo (32) modified the description of the species in the *Sylloge* to include the spores Penzig drew. Cooke's exsiccatum shows that the sarcinaeform conidia are borne on conidiophores with swollen tips similar to those of *M. sarcinula* as now recognised; Penzig did not depict the swellings, but if he identified his fungus by comparison with Rabenhorst's No. 1360, this was an oversight. Penzig also influenced opinion regarding the genus *Macrosporium* by his species *M. rosarium* which he figured (27) and which is evidently congeneric, or nearly so, with his *M. commune*. Berlese (4) followed Penzig, and the only two figures published of *Macrosporium* in Rabenhorst's *Kryptogamen-Flora* do not truly represent the genus. Clements and Shear (10) perpetuate the error of Berkeley by selecting *M. sarcinula* as the type species of the genus (p. 398), which they characterise as having ovoid to oblong conidia. Further, they reproduce Saccardo's figure of *M. commune* as representative of the genus.

Until 1925 species of group (*c*) with sarcinaeform spores have been consistently referred to *Macrosporium*, but in that year Tehon and Daniels erected the genus *Thyrospora* for these species, with *T. sarcinaeforme* (Cav.) as the type species. Bongini (6) has recently pointed out that Tehon and Daniels did not have the correct *Macrosporium sarcinaeforme* as Cavara's fungus was smooth-spored, but none the less, the fungus Tehon and Daniels had was congeneric with the true *M. sarcinaeforme*, and the genus as well as the name *Thyrospora sarcinaeforme* (Cav.) Tehon & Daniels therefore should stand.

Bolle in 1924 proposed that *Macrosporium* should be retained for species of group (*c*). She would ignore Fries altogether as the founder of *Macrosporium* and attribute the genus to Berkeley, basing it upon his species *M. sarcinula*. The proposal cannot be permitted under the International Rules, and to retain the genus in a false sense would be adding to the confusion already existing; if not used correctly the name *Macrosporium* had better be dropped altogether. Brinkman in 1931 reiterates Bolle's views and supports them in their entirety, and Clements and Shear (10) concur.

Conclusions and recommendation

After considering all the facts, I have come to the conclusion that the genus *Macrosporium* should be placed on the list of *nomina ambigua*. The genus has led to much confusion and the sooner it is entirely discarded the better. With *Macrosporium* out of the way, then the first usage of *Alternaria* will hold for group (*ab*), and this appears to be that of Chevallier in 1836. This author bases the genus solely on *A. tenuis* and cites Nees, reproducing his figure. There is no question that Chevallier's usage coincides with that of Nees himself. Alternatively

Alternaria (1836) should be conserved against *Macrosporium*. The genus *Thyrospora* would remain valid for group (*c*). The true genus *Macrosporium* would then become a synonym of *Alternaria*, but a number of species of *Macrosporium* would have to be transferred to *Thyrospora*, either as synonyms or new combinations. The advantages of retaining *Alternaria* for group (*ab*) will be:

(1) that the well-established name *Alternaria*, which had consistently been used in the sense of its founder, would be preserved for the group, otherwise this name must become a synonym of *Macrosporium*; and

(2) that it will obviate the necessity of giving a new characterisation to *Macrosporium* diametrically opposed to the traditional usage of regarding that genus as not having spores in chains.

It has been mentioned that Fries cited *Alternaria tenuis* as a synonym of *Torula alternata*, but presuming that *Macrosporium* is rejected, this citation is not significant, as names cited in synonymy for the first time are not valid (see Art. 37 of the Rules). The only alternative to rejecting *Macrosporium* altogether is to retain it in its true sense, viz. that of *Alternaria*, a proposal which would not be at all likely to prove generally acceptable.

The necessity of action being taken to legalise the solution suggested for clearing up the taxonomic muddle regarding this group of fungi is recognised, but in the hope that such action will be taken the following revised diagnoses for the genus *Alternaria* and for the species *Macrosporium tenuissimum* and *Alternaria Cheiranthi* are appended together with some remarks regarding *A. tenuis*.

Alternaria Nees

Conidiophores, solitary or fasciculate, erect or subdecumbent, simple or branched, mostly coloured, frequently of larger diameter than the mycelium, septate, straight or somewhat irregularly bent, with a single terminal scar, consisting of a circular darkened area with a lighter and apparently thinner central region, or with lateral scars in addition, often geniculate with a scar at each geniculation, continuing growth laterally to the terminal scar, never directly through the scar. Conidia, typically obclavate, consisting of an oval or irregularly oval spore-body, with rounded base and provided with a beak which may be poorly developed, short, thick, hardly defined from the spore-body, or elongated to various lengths, branched or unbranched, of various thicknesses, tapering or filiform, reaching up to as much as five times the length of the spore-body, without longitudinal walls, and sometimes serving as a conidiophore itself; with a basal scar at the point of attachment similar to that of the conidiophore and with the apex of the beak sometimes similarly marked with a scar and sometimes also swollen; borne in chains of

up to twenty or more, which may be branched (simply or moderately) or unbranched, or in chains of fewer individuals (when the conidia are frequently longer beaked) or singly or in occasional chains of two or three (when the conidia have usually long filiform beaks), muriform, with transverse, longitudinal, and sometimes oblique septa, the number of septa varying greatly and longitudinal and oblique septa may be absent in a large proportion of the spores; with the surface generally warted or echinulate but may be apparently quite smooth; often exhibiting secondary growth by the continued division and enlargement of the cells resulting in irregularly shaped conidia and sometimes in the breaking up of the spore-body; and germinating by germ tubes given out from any cell.

Alternaria tenuis Nees

Although the original fungus of Nees has not been identified the description and figure are sufficiently precise to indicate clearly its general structure, so that, whether it proves possible to recognise the species again or not, the author would still regard *A. tenuis* Nees as the type species of the genus. The group of fungi which has in recent years come to be known as *A. tenuis* he would indicate as *A.* "*tenuis*" auct., thus indicating that the name is not valid but that a better name is not available at present. In the course of time the specific limits of the different forms included in the group may be better understood and until this has been done the suggestion made seems the most practical under the circumstances.

Alternaria tenuissima (Fr.), comb.nov.

If *Alternaria* is conserved then clearly *Macrosporium tenuissimum* Fr. must be transferred to *Alternaria* as *A. tenuissima*, a change which I propose. On the basis of Desmazières's specimen the following revised description is appended, though as no recent collection of the fungus has been made it must be expected to need amplification later.

On petals of (?) *Dianthus* and (?) *Ranunculus* forming small dark-coloured spots, with an ill-defined margin, about 0·5–1·5 mm. in diameter. Conidiophores fasciculate, dark-coloured, generally (?) erect, straight or slightly curved, geniculate, bearing from one to six scars, septate, with septa at intervals of about 10 μ, measuring 50–60 × 4–5 μ. Conidia obclavate (almost awl-shaped), 33–103 × 13–20 μ, the diameter widening to a maximum from $\frac{25}{100}$ to $\frac{38}{100}$ of the spore length from the base of the spore and gradually tapering to a beak, from 3–4 μ wide, which occupies about one-third of the spore length, muriform, with up to ten cross-septa, and numerous longitudinal walls, constricted at the septa, with a basal scar and with about half the spores showing an apical scar as well (indicating that the spores were borne in short chains), sometimes with the tip of the

beak swollen and occasionally bearing two or even three scars, light brown (in lactic acid), more or less transparent, and with a smooth surface.

Alternaria Cheiranthi (Fr.) Bolle, excluding specimen

Although Bolle did not have the correct *M. Cheiranthi*, the diagnosis she had in mind in making the new combination was that of the true species and therefore Bolle's name should stand. The following revised diagnosis, however, will apply to this species.

On *Cheiranthus Cheiri* L., occurring on the leaves in yellowish spots, with fairly well-defined margins, 4–13 × 3–8 mm. in diameter, frequently occupying one-half the width of the leaf, with the upper surface covered with a black powdery growth of conidia and conidiophores except for a marginal zone of about 1 mm. wide, and, sometimes, a pale centre, and the lower surface usually insufficiently provided with conidia to produce a blackish appearance, and also occurring on dead or wilting stems or fruits producing a copious blackish olive growth, which may extend over considerable areas, up to 10 cm. in length or more.

Conidiophores, single, or fasciculate in groups of varying numbers up to thirty or more (when such groups are closely placed they appear to constitute much larger groups though the common origin cannot be distinguished owing to crowding), irregularly and densely scattered, especially towards the centre of the spot, from 77–126 × 5–8 μ, light olive-coloured, sometimes almost hyaline, at the apex, mostly simple but may be branched towards the base, which may be swollen, straight or irregularly bent, septate with three to eleven cross-septa, smooth, bearing a single terminal scar at first but later developing up to four scars, which may be borne close together, without marked geniculations.

Conidia borne mostly singly but about 15 per cent. in short chains of from two, more rarely three or more conidia; pear-shaped, ovate, or elongate-ovate at first, later becoming irregularly shaped, roughly spherical, or elongate-cylindrical, with rounded ends, mostly tapering more or less definitely to the apex (which may be drawn out into an elongated beak and bear as many as six scars where secondary conidia have been borne), but sometimes without any indication of one; generally rounded at the base, which is frequently marked by a scar at the point of attachment; septate with numerous transverse, longitudinal, and oblique septa, from three to ten, mostly nine, major transverse septa; constricted at the septa in the mature conidia (except in the region of the beak); light olive-green, sometimes almost hyaline at the apex, translucent, so that the interior cell walls, which are dark, are often plainly visible; usually with a smooth surface, though the conidial wall may be pitted from the interior, 21–97 × 13–32 μ.

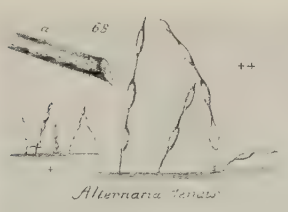

Fig.1

Fig.2

Fig.3

Fig.4

Fig.6

Fig.5

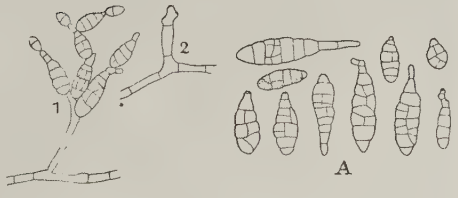

Fig.7

Fig.8

Fig.9

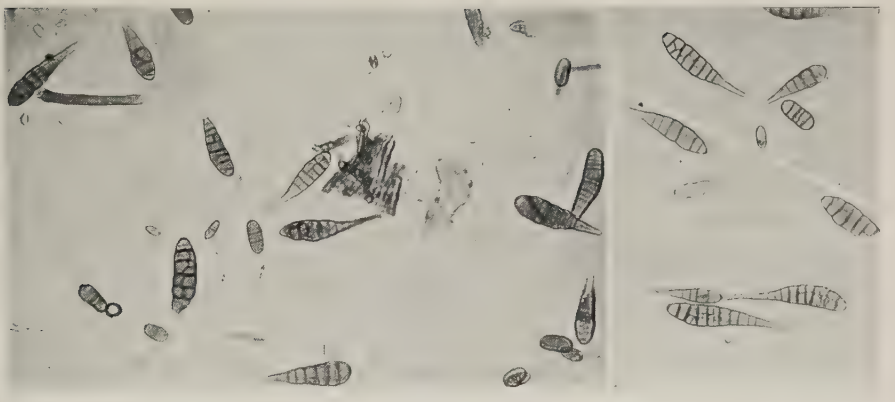

Fig. 10

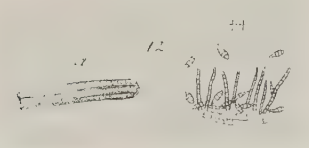

Fig. 11

Fig. 12

Fig. 13

EXPLANATION OF PLATES VI, VII AND VIII

Plate VI

Alternaria tenuis Nees

Fig. 1. Nees's (23) original figure.
Fig. 2. Corda's (13) figure.
Fig. 3. Saccardo's (30) figure.
Fig. 4. Penzig's (25) figure.
Fig. 5. Berlese's (4) figure.
Fig. 6. Elliott's (15) figure.
Fig. 7. Bolle's (5) figure.

Macrosporium Convallariae (Schum.) Fr.

Fig. 8. Schumacher's (36) figure.
Fig. 9. Bonorden's (7) figure.

Plate VII

Fig. 10. *Helminthosporium tenuissimum* Nees, from Desmazières's *Crypt. France*, No. 212. × 200.
Fig. 11. *Helmisporium tenuissimum* Nees, original figure (24).
Fig. 12. *Macrosporium Cheiranthi* (Lib.) Fr., on leaves and fruits of wallflower; collected at Oakley, Hants, in 1930 and 1932.
Fig. 13. *M. Cheiranthi* (Lib.) Fr., vigorous growth of conidia from wallflower. Collected at Oakley, Hants, in May, 1930. × 200.

Plate VIII

Fig. 14. *M. Cheiranthi* (Lib.) Fr., conidia in older stage, same collection as Fig. 13. × 200.
Fig. 15. *M. Cheiranthi* (Lib.) Fr., conidia showing a tendency to divide by the secondary growth of the spore cells. Same collection as Fig. 13. × 200.
Fig. 16. *M. Cheiranthi* (Lib.) Fr., culture on clear maize-meal agar showing catenulation of the conidia in the region of the junction of adjacent colonies. × 200.
Fig. 17. *Alternaria Cheiranthi* sensu Bolle. Bolle's original figures.
Fig. 18. *Macrosporium Cheiranthi* sensu Cooke on *Beta vulgaris*; Cooke's *Fungi Brit. Exsicc.* No. 197 (= Rabenhorst's *Fungi Europaei*, No. 1360) on which Bolle based her identification of *A. Cheiranthi*. × 200.

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THE STIMULATION BY DILUTE ANTISEPTICS OF "SECTORING" IN MOULD COLONIES

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(With 1 Text-figure)

The production of "sectoring" in mould cultures has frequently been recorded, and the nature of the medium has sometimes been

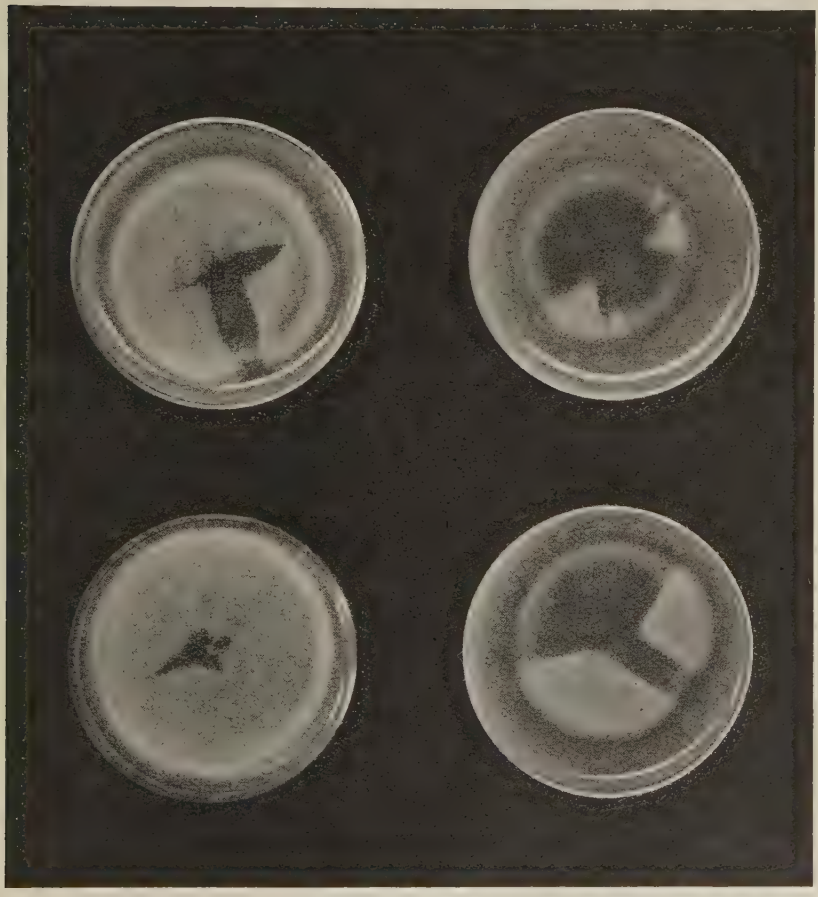

Fig. 1. Colonies of *Aspergillus terreus* showing "sectoring."

shown to be a contributory cause. The object of the present note is to call attention to the influence of antiseptics on this type of variation.

It has been observed, in the course of a long series of trials of possible antiseptic substances, that sectoring is sometimes stimulated by dilute chemicals. One of the most marked instances is that of *Aspergillus terreus* grown on flour agar (2 per cent. wheat flour, 1½ per cent. agar) in the presence of salicylanilide. A concentration of 0·003–0·005 per cent. of the sodium salt of salicylanilide does not appreciably affect the rate of growth; in the majority of colonies, however, sectors of a lighter colour are developed.

The production of similar light areas, where sporing is more scanty than in the normal colony, has been recorded by Rege(1) and by Norman(2) for *Sepedonium*.

Transfers to wort agar slopes have been made at fortnightly intervals. After four subcultures the white and the normal type with sand-brown spores still remain quite distinctive. Both show approximately the same resistance to salicylanilide when transferred back to a medium containing the antiseptic.

The colonies have been obtained by ordinary needle transfers, and not by single spore inoculation. The sectoring, however, cannot be attributed to a mixed inoculation for the following reasons:

(1) The culture used (B.C.I.R.A. record 48) has been plated several times, and is therefore almost certainly derived from a single spore, and one moreover that has not suffered mechanical manipulation.

(2) The sectors often arise some distance from the centre of the colony.

(3) The sectoring occurs only in presence of the antiseptic.

I am indebted to the Director of Research of the British Cotton Industry Research Association for permission to publish this note.

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NOTE ON AN UNUSUAL MOULD FUNGUS

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(With 2 Text-figures)

The mould which is the subject of the following note was obtained from a cop of cotton yarn, heavily mildewed with *Stachybotrys* sp., and kept for some years in a sealed jar.

Repeated plating out indicated that the *Stachybotrys* spores were non-viable, but a single colony of a dematiaceous organism developed on one of the plates. It is, of course, quite possible that the isolated colony was an air infection, and not from the mildewed cop.

This mould (B.C.I.R.A. collection 193) combined the dematiaceous appearance of *Stachybotrys* with the structure of a monoverticillate *Penicillium*, and bore spores resembling those of *Aspergillus niger*.

Growth on wort agar is at first white, later becoming pinkish with buff reverse. A black velvety sporing area gradually extends from the centre.

On nutrient agar (0·05 per cent. each of peptone, lemco, and sodium chloride), an orange pigment diffuses into the medium.

On Dox's agar there is a sparse whitish growth, and a brown coloration of the medium.

On Biourge's "Raulin-Dierckx neutre" there is a deep reddish brown coloration of the medium, and no liquefaction of gelatin.

Acid is produced in litmus glucose broth.

Sterile hyphae hyaline, septate; conidiophores without foot-cell, erect, septate, with dark pigment and warted with dark granules, 50–100 $\mu \times 3$–4 μ. The tip of the conidiophore shows slight enlargement into a rudimentary vesicle, from which the sterigmata are developed successively. Sterigmata 7–9 $\times$ 3–4 μ, usually about seven; conidia one-celled, spherical, with black pigment, and with a warted surface recalling the spores of *Aspergillus niger*, 4·5 μ in diameter, with little variation in size, and borne in basipetal succession, in divergent unbranched chains of a dozen or more. The spores show no connective, and no other spore-form has been observed.

A search of the literature revealed two descriptions which probably refer to the organism, one by Rivolta (1), the other by von Höhnel (2).

Rivolta's organism was somewhat scantily described and his illustration (Fig. 1) is also somewhat unconvincing. It is highly probable, however, that his *Penicillium echinatum* is identical with the present species. (*Penicillium echinatum* Riv. should not be confused

with *P. echinatum* Dale, which Thom considers synonymous with *P. nigricans* Bainier.)

Saccardo transferred Rivolta's species from *Penicillium* to *Haplographium*, presumably solely on the ground of its dematiaceous character. The description of *Haplographium echinatum* (Riv.) Sacc. given in Rabenhorst is as follows:

"Schwarz. Konidienträger aufrecht, septiert, schwarz, 60–70 μ lang, oben kurze, sterigmenartige Ästchen tragend. Konidien in Ketten, schwarz, kuglig, warzig, 3–4 μ im Durchm.

"Auf Heu und auf Weizenstengeln in Norditalien (Rivolta)."

Von Höhnel's organism, which he compares to a black *Penicillium*, was isolated from cotton yarn in Vienna, and is described by him as *Memnoniella aterrima* n.g., n.sp. He considers it has formerly been

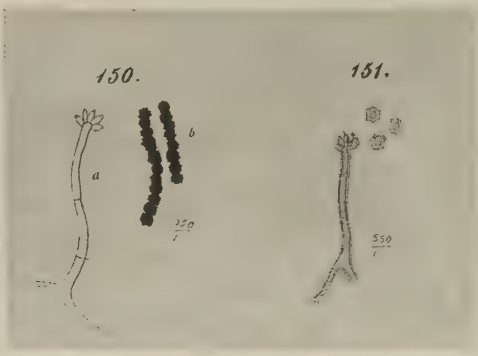

Fig. 1. Rivolta's figure of *Penicillium echinatum*.

classified under various genera, including *Haplographium*, but gives no illustration and makes no mention of Rivolta's organism. The description agrees well with the present sp. 193, the chief point of difference being that the spores are described as disc-shaped 5–5·5 $\mu \times$ 3·5–4 μ. Von Höhnel's diagnosis is as follows:

"*Memnoniella* v. Höhn. n.g.

"Hyphomyc. dematieae. Konidienträger schwärzlich, einfach, septiert, an der Spitze 1–2 Quirle von länglichen, einzelligen konidien-bildenden, kurzen, fast parallelen Zweigen tragend, die lange, persistente Ketten von gefärbten einzelligen Konidien bilden. Nährmyzel hyalin, spärlich.

"*Memnoniella aterrima* v. Höhn. n.sp.

"Rasen klein, dicht, kohlschwarz, aus einfachen, 60–80 μ langen, 3–3·5 μ dicken, 2–3 mal septierten, schwärzlichen, aufrechten, an der Basis hyalinen Fruchthyphen (mit spärlichem hyalinem Nährmyzel) bestehend. Träger an der Spitze ein etwa 14 μ breites und 10 μ hohes Köpfchen bildend, das aus 1 bis 2 dichtstehenden Quirlen von etwa

10 subhyalinen, einzelligen, etwa 8 μ langen, 3 μ breiten, etwas divergierenden Zweigen besteht, die an der Spitze persistente, bis 200 μ lange Ketten von opak-schwarzen, rundlich-eckigen, meist höckerigen, fast scheibenförmigen, 5–5·5 μ breiten, 3·5–4 μ dicken Konidien bilden."

A herbarium specimen of *Haplographium delicatum*, the type of the genus, was examined by Mr E. W. Mason; it shows marked differences

Fig. 2. *Memnoniella echinata*, sp. 193. × 1600.

in structure from sp. 193 and from Rivolta's species. The type specimen of *Memnoniella aterrima*, on the other hand, is stated by Dr D. H. Linder, of the Farlow Herbarium, Harvard University, to agree perfectly with a culture of sp. 193 examined by him. Dr Linder writes, "The spores of the type are not all disc-shaped but rather of a squarish outline, given by the warts on the surface of the spores."

It appears, therefore, that the generic name *Memnoniella* should be retained. This will entail the making of a new combination, *Memnoniella echinata* (Riv.).

The organism is obviously closely related to *Stachybotrys*, from which, however, it is sharply differentiated by the fact that the globose spores are borne in chains. Cultures of this organism have been deposited with the National Collection of Type Cultures (Lister Institute), and the Centraalbureau voor Schimmelcultures.

I am indebted to the Director of Research of the British Cotton Industry Research Association for permission to publish this paper, and to Miss E. M. Wakefield, Dr D. H. Linder, and Mr E. W. Mason for references to the literature and help in identification of the fungus.

REFERENCES

(1) Rivolta, S. *Dei Parassiti Vegetali*, Ed. II (1884).
(2) von Höhnel, F. *Centr. f. Bakteriologie*, Abt. 2, LX (1923), 16.
(3) Lindau, G. In Rabenhorst, *Kryptogamen-Flora*, Ed. II, I (1906), Abt. 8, 697.

DATES OF PUBLICATION OF SOWERBY'S *ENGLISH FUNGI*

By J. RAMSBOTTOM

Mr F. J. Griffin, Registrar of the Royal Entomological Society of London, recently purchased a copy of Sowerby's *English Fungi* in the original wrappers in a lot at a sale and very kindly gave me the chance to acquire it. I know of no other example of the work in this condition and have thought it of interest to give the correct dates of publication. The work was published as three volumes and a supplement, the dates on the title-pages being: Vol. I, 1797, Vol. II, 1799, and Vol. III, 1803: there is no title-page to the supplement.

The wrappers are of "the ordinary blue paper" and are without general advertisements except on the back wrapper of No. xxix, where there is a prospectus of Sowerby's publications.

There are twenty-seven parts in the body of the work and five supplementary parts. The dates of these were as follows:

	Volume I	
No. i.	January, 1796	Tab. 1–5
ii.	February, 1796	6–10
iii.	March, 1796	11–15
iv.	April, 1796	16–20
v.	May, 1796	21–25
vi.	June, 1796	26–30
vii.	July, 1796	31–35
viii.	August, 1796	36–40
ix.	September, 1796	41–60
x.	January, 1797	61–80
xi.	May, 1797	81–100
xii.	September, 1797	101–120
	Volume II	
No. xiii.	January, 1798	Tab. 121–140
xiv.	May, 1798	141–160
xv.	September, 1798	161–180
xvi.	January, 1799	181–200
xvii.	May, 1799	201–220
xviii.	September, 1799	221–240
	Volume III	
No. xix.	January, 1800	Tab. 241–260
xx.	May, 1800	261–280
xxi.	September, 1800	281–300
xxii.	January, 1801*	301–320
xxiii.	September, 1801	321–340
xxiv.	January, 1802	341–360
xxv.	September 1, 1802	361–374
xxvi.	January 1, 1803	375–378
xxvii.	July 1, 1803	379–400

* May 1, 1801; cf. p. 169.

SUPPLEMENT*

No. XXVIII.	February 1, 1809 ... ... (or No. I of the Supplement)	Plates 401–406
XXIX.	April 1, 1809 ... ... (or No. II of the Supplement)	407–412
XXX.	November 1, 1814 ... ... (or No. III of the Supplement)	413–423 (438)
XXXI.	December 1, 1814 ... ... (or No. IV of the Supplement)	424–429
XXXII.	January 1, 1815 ... ... (or No. V of the Supplement)	430–440

The wrapper of the first number reads:

NO. I.

Price Two Shillings and Sixpence

(To be continued Monthly)

OF

COLOURED FIGURES

OF

ENGLISH FUNGI or MUSHROOMS

BY JAMES SOWERBY, F.L.S.

Designer of English Botany etc.

..."Was evr'y faltr'ing tongue of man,
Almighty Father! silent in thy praise,
Thy works themselves would raise a general voice:
Even in the depth of solitary woods,
By human foot untrod, proclaim thy power."

LONDON: Printed by J. DAVIS;

And sold by the Author, James Sowerby, No. 2 Mead Place, near the Asylum; and Messrs. White, Booksellers, Fleet Street; Johnson, St. Paul's Church Yard; Symonds, Paternoster-Row; and by all Booksellers, etc., in Town and Country.

It was not the Author's intention to have published this work, till he had nearly finished a laborious undertaking in which he has for some time been engaged, the making coloured models of English Fungi in their different states, and thus as much as possible ascertaining and fixing the limits of each species:—But that project being very extensive, it has been thought proper to begin publishing such as are least doubtful, in hope that in the mean time a more perfect knowledge may be daily acquiring of such as are to be given to the world hereafter.

The letter-press will be concise, the Author being always more disposed to employ his pencil than his pen. The plates will be numbered for the sake of reference, and the names will be as correct as possible in so difficult a tribe. Each number will contain five plates in small folio, with one or two pages of letter-press to the five plates.

As Four Numbers are finished, those who desire it may take the whole together.

N.B. Four more Numbers will be ready on the first of May.

* The numbering of the plates in the Supplement is confusing. Tab. 420 and 438 are on one plate as are also Tab. 422 and 423 and Tab. 439 and 440. Tab. 427 is figs. I and II on Tab. 425. Tab. 435 and Tab. 437 are both wrongly numbered, 436 in many copies being omitted.

No. v has the slight change: "As Eight numbers are finished...." With No. ix the method of publication was altered. "Each number will contain twenty plates in small folio, with eight pages of letter-press to the twenty plates." The phrase "to be continued monthly" is omitted and the price changed. The reason for the alterations is given on the back wrapper:

"On Account of certain Regulations at the Stamp Office, founded on an Act of Queen Anne, relative to the Publication of Pamphlets not containing a Sheet of Letter-press, it becomes necessary to publish the Quantity of Four Numbers in One. The present No. ix, therefore (Price Ten Shillings), contains Twenty Plates with their corresponding Descriptions; the following Number will come out on the First of January, the next on the First of May, and so on; Twenty Plates with their Descriptions being published in future every Fourth Month, instead of Five every Month."

On the back wrapper of No. x (repeated in No. xi) is the statement:

"The Title-Page and Preface of this Work are intended to be given with the 120th Plate, which is to finish the First Volume. At the same Time we hope to add a Nomenclature, or Index, with the Synonyms of different Authors, indicating the numerous Varieties which appear to have been confounded with Species."

Notes on wrappers in Vol. III:

No. xxii. "This Number was intended to be published on January 1, 1800, but was unavoidably delayed till May 1, 1801. We hope to continue them regularly every 4th month in future till finished."

No. xxiv. "The Author intended to have finished this Volume with the present Number; but thinking two more may conclude the Work, it is proposed to add them to the Volume: and as it will take some time to settle what remains, No. xxv will not be ready till July 1, 1802; and No. xxvi, January 1, 1803."

No. xxv. "The Author expected to have published this Number July the 1st, 1802, but was unavoidably disappointed.

Should any of Mr. Sowerby's friends meet with *Sphaeria entomorrhiza* of Dickson, he would be much obliged by a Specimen." (This was repeated on all the remaining wrappers though in the Supplement it is "Mr." Dickson.)

"The figures in this Number being more than usual, the destined number of pages would not hold the descriptions; they will therefore be put in the following Number." (This is the page giving the descriptions of Pl. 373, figs. 9–12, and Pl. 374, Figs. 1–9.)

No. xxvi. "The remainder of the letter press for this Number is expected to be ready about the 1st of May 1803; and may then be had at the usual places for the price of paper and printing."

No. xxvii (inside of back wrapper). "Seeing that this work cannot be completed in less than two or three more numbers, and that to procure some of the subjects will necessarily prolong the period of publication, it is thought best to put the title and index in the present number (*viz.* No. xxvii), and to publish the remaining numbers in the form of a supplement; and while gratefully thankful for the many friendly assistances received, we still hope a continuance of them in this or any other branch of natural history.

Tab. 401 is a figure of the true *Lycoperdon recolligens*, which we lately received from the Rev. Mr. Jas. Dalton*, of Copgrove, Yorkshire. It will be described hereafter, as it was too late for the present number. The Lycoperdon, figured at tab. 80, may at present be considered as a sessile variety of *L. stellatum*, tab. 312."

[* Godfather of Sir Joseph Dalton Hooker.]

Notes on wrappers of Supplement:

No. XXVIII. "The Second Number of the Supplement is intended to contain an account of the varieties of the Fungus lately so fatal at Mitcham, etc., and to point out to the public the most distinguishable characters by which it may be avoided. It was hinted to Mr. Sowerby to contrive such a Number for public use; and it is hoped that those who possess this Number will give as much publicity to this part of the subject as may guard against future mischief."

No. XXIX. "This Second number...contains...points out.

Erratum in No. XXVIII. Tab. 404. For *Clavaria rugosa*, read *Clavaria Fabae*."

The only alteration in the general set-up of the printing of the wrappers is that the name of the printer changes to Davis, Wilks, and Taylor, Chancery-Lane (No. XXI); to Wilks and Taylor, Chancery-Lane (No. XXIII); to Richard Taylor and Co., Shoe-Lane (No. XXVIII) and to R. Meredith, 21, Silver-Street, Wood-Street, Cheapside (No. XXIX). There are also slight changes in the Booksellers towards the end and the author describes himself in the Supplement as "Designer of English Botany, Author of British Mineralogy, The Botanical Drawing Book etc., Honorary Member of the Physical Society of Göttingen, etc."

It was a matter of surprise to find that throughout my copy the watermarks of the plates are often of a much later date than that given on the plate or on the wrapper. Thus in the first twenty-seven plates there are six different makes of paper with dates ranging from 1794 to 1817. The explanation is probably that Sowerby, after the first printing, made up additional copies as he required them, using his general stock of paper*. The copy in the Department of Botany, British Museum, has watermarks all of dates not later than that of publication.

The Department of Botany, British Museum, possesses many of Sowerby's original drawings—those of fungi including nearly all of those of *English Fungi*. These latter (and Sowerby's mycological herbarium) were presented to the Museum by M. J. Berkeley in 1876.

There is also a set of proof plates, coloured by Sowerby as guides to the print colourers. A useful commentary on the original drawings and a comparison with the published plates by Worthington G. Smith, with the title "Sowerby's Drawings of Fungi," will be found in the *Journal of Botany*, XLIII (1905), 156–60, 180–6, 207–15, 239–43, 258–66.

The drawings made by Sowerby for his *English Botany*, and for J. Dickson's *Fasciculus Plantarum Cryptogamicarum Britanniae*, as well as many original drawings, which, though drawn for publication, were never engraved, are also listed by W. G. Smith, *tom. cit.* pp. 319–23.

* Although the alterations in the numbers of some of the plates, *e.g.* 367 from 337 and 368 from 338, have been made less obvious by hammering out and restamping, the numbers 205 and 206 and 407 and 408 are still reversed.

LABORATORY DEVICES

By B. BARNES

(*Department of Botany, Birkbeck College, University of London*)

(With 1 Text-figure)

I. An aid to photomicrography

When living cultures of delicate fungi are uncovered, water is rapidly lost from the aerial hyphae, and the resulting movement is often sufficient to prevent satisfactory photomicrography. If the cultures are left uncovered until movement ceases, collapse is so great that the fungus is no longer worth photographing. Attempts to take photographs through the lid of the Petri dish are hindered by reflected light, by optical effects due to inequalities in the thickness of the glass, by the limitations placed on the kinds of objectives that can be used, and by clouding of the inner surface of the lid. Clouding may be dispersed by placing a piece of warm sheet copper on the outside of the lid, above the spot to be photographed, but, as a rule, so much heat has to be used to clear the relatively thick glass that subsequent radiation provokes movement of the hyphae.

All these troubles may be overcome by the use of a simple device (Fig. 1). In the lid of a Petri dish of the size commonly used by the worker, an elliptical hole is made, the major axis of the ellipse lying radially and extending from near the periphery to beyond the centre of the lid, the minor axis being about 1 in. in length. Strips of glass are fastened to the under side of the lid by Chatterton's compound, so as to form a frame round the hole. Finally, a piece of cover-glass of suitable size is attached to the frame by Canada balsam, and, when this has set, the device is ready for use. The thickness of the strips of glass used for the frame must be such that the fungus is not crushed on to the medium; this thickness will depend on the height to which the fungus commonly grows, the depth of agar generally used by the worker, and the kind of objective it is proposed to use.

Holes are readily made in lids with hydrofluoric acid, paraffin wax being used to protect the rest of the glass: such holes always have a somewhat uneven margin, but this is of no consequence. If suitable apparatus is available, holes can be drilled and ground to a smooth edge. Attempts to make holes with glass cutters have always failed.

When a photomicrograph is to be taken, the lid of the dish containing the culture is quickly replaced by a cleaned, prepared lid, and the culture is allowed about half an hour in which to settle down. The dish is then placed under the microscope, and, by moving the

dish and turning the lid, all parts of the medium except the extreme edge can be brought under the elliptical hole. Consequently, unless the culture is an old one, any part of the colony is within reach of the objective.

Moisture may condense on the lower surface of the cover-glass, but such moisture is easily dispersed by slight warming, so slight that it has not been seen to cause movements in the hyphae.

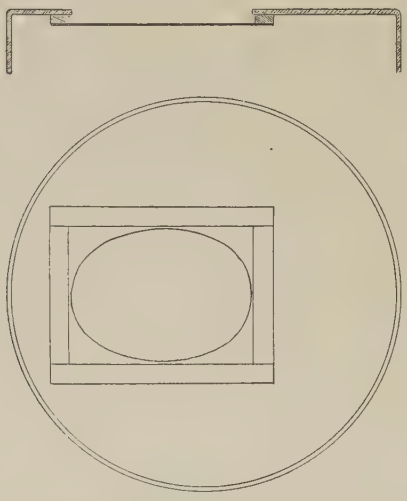

Fig. 1. Elevation and plan of lid of Petri dish prepared for use in photomicrography (for explanation, see text).

The prepared lid cannot be sterilised by heat. It may be used for the direct examination of cultures when risk of contamination is of no account. The depressed area bridged by the cover-glass allows of the use of moderately powerful objectives.

II. To protect cultures from mites

Cultures in Petri dishes may be protected effectively against mites by keeping the dishes on supports surrounded by water. Small earthenware vessels, whose diameter exceeds that of the dishes used by about an inch, form convenient water pots. Supports must be firm enough to sustain a pile of dishes of reasonable height, and they should be made of a substance not affected by water. They should not occupy a large proportion of the space inside the water pot, for the more water the pot contains the less is the risk of drying up.

Leaden tripods meet all the requirements. Their weight makes for stability, and they are easily bent so as to stand firmly even if the bottom of the water pot is uneven. Suitable leaden tripods are easily

cast in the following way. Slightly moistened sand is rammed firmly into a large tin, and smoothed to a level surface. The bottom of a clean and dry push-bottom bottle, whose diameter is somewhat less than that of the Petri dishes used, is pressed into the sand to a depth of about half an inch, and, when withdrawn, leaves a clear-cut circular trench. Three equally spaced vertical holes are then made from the bottom of the trench, by pushing a pencil into the sand to a depth somewhat exceeding the length of the legs of the finished tripod. The mould so prepared is filled with molten lead, and when cool, the legs of the tripod are trimmed all to the same length. The sand is again firmed, a new mould made, and the subsequent operations repeated. If two tins of sand are used, tripods can be made by a single worker at the rate of about twenty an hour. It is not necessary to wait for the lead to cool completely before taking it out of the sand; the tripod can be withdrawn with a pair of tongs as soon as the metal has set.

The tripods are placed in the water pots with the heavy ring downwards, the Petri dishes being placed on the upturned legs, an arrangement which increases stability.

The water pots may be kept full in a very simple way. If they are arranged in groups, each pot may be connected with its neighbours by means of bent glass tubes full of water; these tubes act as siphons, and maintain a uniform level of water in all the pots. It is therefore only necessary to replenish the water in one pot at the end of each series.

III. Steam cooking for media

Steam cooking has been found of great service in the preparation of media, for there is no risk of burning, and, once the height of the gas under the generator has been suitably adjusted, the apparatus needs little watching.

A one-gallon tin can provides a suitable generator. Such a can, about half full of water and fitted with an open vertical tube of small bore, acting as a safety valve, together with the necessary number of delivery tubes, yields enough steam to cook material in three or four flasks at the same time. Relatively bulky materials, such as prunes and pieces of potato, are immersed in water in a flask, and the end of the delivery tube placed under the water. Finely divided material, such as oatmeal, is made into a paste with cold water, and steam is blown through the paste. As condensation goes on, the paste is thinned, and the continual motion ensures the preparation of a porridge free from lumps: this is diluted with hot water to the concentration desired, and, after addition of agar, sterilised in the usual way.

SYMPOSIUM AND DISCUSSION ON THE MEASUREMENT OF DISEASE INTENSITY

HELD ON JANUARY 21ST, 1933, IN THE BOTANICAL DEPARTMENT, UNIVERSITY COLLEGE, GOWER STREET. THE PRESIDENT, PROFESSOR W. BROWN, D.Sc., IN THE CHAIR

I. POTATO BLIGHT

By A. BEAUMONT
(*Seale-Hayne Agricultural College*)

In the literature of plant pathology very few attempts at making accurate measurements of the amount of disease in a crop in any given plot or district have been described. Measurement is essential to the development of plant pathology. Without measurement of disease and rate of spread, it is impossible to form accurate conceptions of susceptibility and resistance, or to decide if the amount of disease to-day is greater or less than formerly, the economic importance of any given disease, or the relation of weather to the growth and spread of diseases.

Practical difficulties have no doubt been the chief deterrent to the measurement of disease. Very detailed measurements are impossible owing to the time and labour involved in making them. The requirement is a simple and comparatively quick method that can be standardised for use at different times by different persons in different places, and it must be sufficiently accurate to permit confident comparison of the results of its application. The method adopted will naturally differ with different diseases, but it is hoped that by pooling the views of the various workers on any given disease, a standard method for universal application may eventually be devised.

It is important to distinguish between the amount of disease (*e.g.* the number of lesions, or the number of plants bearing lesions) in a given crop at a given date, and the rate of increase in the amount of disease over a given period. Frequently investigators compare only the amounts of disease, when they should compare the rates of increase.

The types of methods of measurement available are:

(*a*) Measurement of crop yield.
(*b*) Area measurement.
(*c*) Grading and counting.

Measurement of yield is often used, but is the least satisfactory method, as there is so much individual variation in cropping, thus

necessitating replication of plots; moreover, the figure represents only the end-point in the progress of the disease. Area measurement is easy, but is applicable only in certain cases, *e.g.* where the plant completely succumbs to a single infection. A good example of a disease to which it can be applied satisfactorily is Carnation Wilt in greenhouses. The area of the patch of wilted plants can be measured very quickly, so that graphs of the rate of progress would not be difficult to make. Grading and counting is the method most generally applicable, but is very laborious unless sampling is possible. It has been used by workers on Apple Scab, as described below, and its adoption is to be recommended for Apple Canker (*e.g.* number of lesions on each year's wood) and Finger-and-Toe (*e.g.* number of roots healthy, number diseased but marketable and number badly diseased). Sampling methods must be worked out with the aid of a statistician.

The measurement of potato blight

Probably no disease is more difficult to measure than Potato Blight. I have been engaged in field observations on this disease for some years and have applied different methods. It must be decided first of all whether to measure the disease on the foliage or in the tubers. If the latter method is adopted, only one measurement is possible and that at the end of the season; further, disease in the tuber depends on many accidental factors, such as the amount of earthing up and the nature of the soil, which bear no relation to the progress of the disease. Measurement of the disease on the foliage is therefore preferable, though unfortunately much more laborious.

The methods available are:

(1) The number of lesions.

(2) The number of plants bearing lesions. (The plants could be graded according to whether the lesions are few or many.)

(3) The surface area of lesions.

(4) The area occupied by diseased plants.

The first two methods have been used for several seasons, the third was rejected as being too laborious and the last gave very little information in small fields. Counting was possible only on sample plots. These were marked out at random when the tubers were planted. Notes were made of the occurrence of the disease outside the sample plots. The results for 1932 proved to be of considerable interest and may be quoted to illustrate the value of the method.

A field at Seale-Hayne Agricultural College was planted on the same day with sprouted tubers of the variety Majestic, Scotch seed. The plots (*A*, *B*, *C*, *D*) on which the counts were made consisted each of four rows of five to seven plants, and the number of lesions and the number of attacked plants were counted on each. The figures for

the number of lesions were more useful, for the disease spread rapidly and all plants became infected within a few days. Blight first appeared on July 18th on plants outside the plots. When the results were plotted as a graph (see Fig. 1) an interesting difference between plots *A* and *C* and plots *B* and *D* was observed; the rate of increase of blight was very much less in the former than in the latter. This difference is explained by the large amount of infection observed on the plants adjoining *B* and *D* compared with that on the plants near *A* and *C*. The measurements, therefore, express clearly the relation of the amount of fungal infection to the rate of spread of the disease.

This example illustrates in a simple manner the information that disease measurement is able to provide.

Can this method of measuring blight be standardised in such a way that it could be carried out by different observers with comparable results? This question cannot be answered without first putting it to a practical test, but there are no difficulties of technique, and time alone limits the number and size of the plots to be counted. Single measurements are of little value, for it is the rate of increase in the amount of disease that provides the most useful information. It has already been shown that the rate of increase is governed by the amount of fungal infection, which is difficult to regulate or assess. It depends also on the weather and on the susceptibility of the plants attacked. Before useful comparison can be made between the results in different places, two of these three factors must be as nearly as possible identical in their relation to the disease. It will be difficult but not impossible to arrange this, and further work of a co-operative nature with this end in view is much to be desired.

The measurement of Potato Blight is possible, but standard conditions are needed to ensure that the measurements are capable of providing information of value.

II. APPLE SCAB

By R. W. MARSH
(*Long Ashton Research Station*)

Need for standardisation

Workers on Apple Scab are agreed that the extent of the disease in any given sample of apples can be expressed most satisfactorily in terms of the total area of scab on each fruit. Commonly the results are given by stating the percentage number of fruits falling into classes, each class including all the apples having some stated range of total scabbed area. The following are the systems that have recently been used:

Goodwin, Salmon and Ware (1) employed a classification into three grades:

Grade I consists of apples free from scab—with the proviso that any apple with not more than three very minute spots (each not larger than a pin's head) could be included.

Grade II consists of apples on which scab spots were few or many but the fruit was not unmarketable.

Grade III of apples so cracked or disfigured by scab as to be unmarketable.

Petherbridge, Dillon-Weston and Kent (2) divided fruit into three classes:

(*a*) Scab-free.

(*b*) With a total scabbed area not greater than that covered by a sixpence.

(*c*) Badly scabbed.

M. H. Moore (3) estimated scab by a category method which he described as follows:

"A definite maximum area of scab was fixed for each category, so that each maximum area was approximately double that of the category next beneath it. The choice of types was made by inspection after the range of severity of infection had been gauged. In addition there was one category in which the fruits were scab-free: this was numbered 0. The next category was numbered $\frac{1}{4}$ and the others in ascending order were numbered $\frac{1}{2}$, 1 and 2.

"The number of fruits in each category was found and multiplied by the category figure. The products were added and gave a sum which formed the numerator of a fraction, the denominator of which was the total number of fruits.

"For example: Total fruits, 100.

Category figure	0	$\frac{1}{4}$	$\frac{1}{2}$	1	2	
Category frequency	30	32	24	10	4	
Category value	0 +	8 +	12 +	10 +	8	= $\frac{38}{100}$

"The fraction, multiplied by an arbitrary constant number, gave the 'scab equivalent.'"

Marsh (4) used a modification of the above method, dividing the fruit into five categories as follows:

(i) Entirely free from scab.

(ii) Scabbed area not exceeding a total of $\frac{1}{4}$ in. square.

(iii) Scabbed area exceeding a total of $\frac{1}{4}$ in. square but not exceeding a total of $\frac{1}{2}$ in. square.

(iv) Scabbed area exceeding a total of $\frac{1}{2}$ in. square but not exceeding a total of 1 in. square.

(v) Scabbed area exceeding a total of 1 in. square.

Muskett and Turner (5) employed only the two divisions "Clean" and "Scabbed," every apple showing the slightest trace of disease being classed as scabbed.

Cheal (6) distinguished four grades, described as

(*a*) Entirely free.

(*b*) "Pin-spot."

(*c*) Bad (aggregate spots more than the size of a threepenny piece and under the size of a shilling).

(*d*) "Bag" apples.

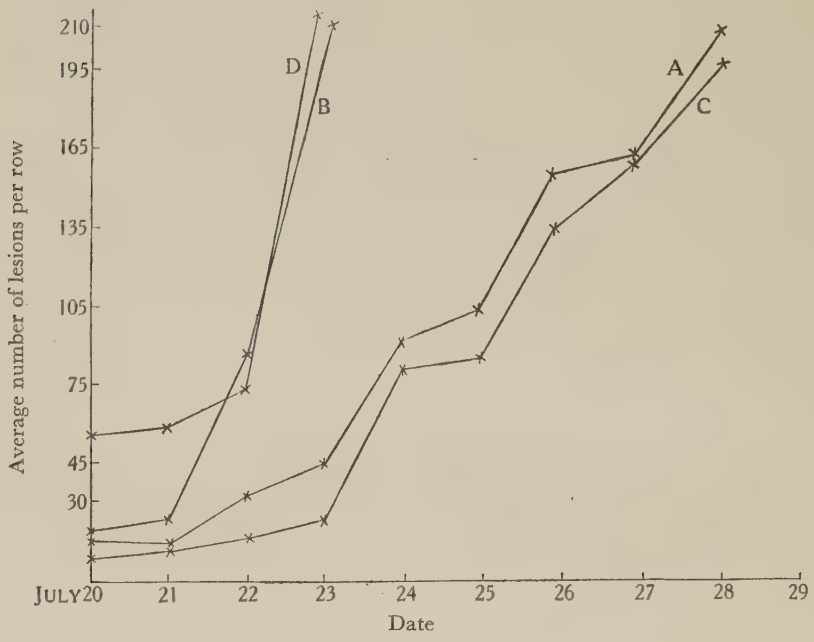

Fig. 1

It will be seen that each investigator has employed a different system of classification and that, with the exception of Muskett and Turner's, the results of no one method can be expressed in terms of any other. It would be of considerable benefit if an agreed system of categories could be put forward, with the suggestion that where any broader classification was required it should be erected by combining the categories given into two or more larger groups, as convenient.

Application of standards under field conditions

A single worker, using an automatic counter, can rapidly record fruit as clean or scabbed, but an assistant is needed if the fruit is to be counted into more than two categories. Counting is usually done immediately after picking, either when the fruit is being transferred from the pickers' baskets to the orchard boxes, or when sample orchard boxes are turned out and sorted in the plantation or at the fruit store. Where the apples are grown on bush trees, however, it is frequently possible to carry out scab estimations on the fruit previous to picking. With the help of an assistant to note down the category numbers, such estimations can be made at the rate of five hundred fruits per hour. Greater rapidity is possible if the fruits are recorded as they are passing over a Cutler grader, since on this machine each part of the surface of the apple is presented to view without the necessity for handling. An investigator and assistant working beside a grader can record at the rate of two thousand fruits per hour.

The estimation in four grades of total area of scab per fruit does not present any special obstacles in practice. Concordant results have been obtained even by those relatively inexperienced in scab recording. It is believed that any agreed system capable of being illustrated by diagrams or models could be used without difficulty by all concerned in this problem.

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III. STATISTICS

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IV. AN ATTEMPT TO MEASURE THE INTENSITY OF AN ATTACK OF NET BLOTCH (*HELMINTHOSPORIUM TERES* SACC.) ON BARLEY

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The yield of barley in 1930 and 1931 on the College Farm at Wye had shown a decrease of one to two quarters per acre, and as the crops had been heavily infected with Net Blotch it was considered that the disease might have decreased the yield. It is well known that Leaf Stripe (*Helminthosporium gramineum* Rabenh.) is detrimental to the crop, but according to Brooks (*Plant Diseases*, London (1928), p. 195), Net Blotch does not seriously affect yields.

An attempt was made in 1932 to control the disease by the use of various seed dressings before sowing; control plots with infected but untreated seed were included and the ultimate valuation of the trial was to be the yield of grain per acre. The materials used for dressing the seed were: (1) Ceresan, (2) Agrosan (A), (3) Agrosan (B), (4) Mercuric chloride dust.

A uniform area of land was selected and the trial was designed in the form of "randomised" blocks. Four blocks were laid out with a plot of each of the four treatments and a control plot in each block, the positions of the plots inside the block being determined by "randomising." Each plot was 1/40th acre, and to facilitate drilling and other cultural operations, the blocks were placed side by side, making twenty strips of land across the field.

On February 6th the seed was dressed with the materials to be tested and the seed was drilled. Here the first difficulty arose; the drill had been set to sow three bushels per acre and the control plots, Ceresan and mercuric chloride plots were sown with 21 lb. of seed, but when the amount of seed sown on the Agrosan plots had been calculated it was found that only 14 lb. of seed had run through the drill. This detail is mentioned to illustrate the difficulties encountered in this trial, and does not necessarily intend to convey the impression that seed dressed with Agrosan does not run normally through a drill. If the shutters on the drill had been opened further, the delivery would probably have been satisfactory. An attempt was made subsequently to overcome the difficulty by broadcasting enough seed to bring the total sown on each plot to 21 lb.

All cultural operations were the same as on the rest of the field of barley. When the plants appeared above ground, none of the plots was noticeably in advance of the others. The plots were under observation continuously and in May the disease was observed on plants on the control plots. The difficulty of finding a suitable method of measuring the extent of the infection now presented itself. The area of the trial was half an acre and it was clearly impossible to measure the amount of infection by any exact method; it was decided therefore to count "points of infection," these being interpreted as being any infected plant or group of plants with no break of unaffected plants. It was assumed that a point of infection may have originated from one infected seed, but, on the other hand, single plants and groups of plants were indistinguishable, especially after tillering had begun, and infection may have spread from any one plant originally infected.

This method had its limitations, for on the control plots practically every plant showed infection in the later stages, and some other arbitrary method of counting had to be used.

The points of infection were counted by the use of a sampling method. A rod 4 ft. long was placed in ten "randomised" positions in each plot, the "randomising" being controlled to ensure the covering of the plots. As each treatment was replicated four times, there was thus a total of forty rod readings for each of the treatments. The first count was taken on May 19th. As the numbers of plants per 4 ft. rod were uneven, a note was taken at each placing of the rod of the "plant," which was recorded as (*a*) good, (*b*) fair, or (*c*) poor. Approximately, a good "plant" had three times as many plants per rod as the poor "plant" and twice as many as the fair. In calculating the results the points of infection on a poor "plant" were multiplied by three and those on a fair "plant" were multiplied by two, it being assumed that infection would increase in proportion to the number of plants.

Having corrected the figures for "plant," an analysis of variance was calculated, and it was shown that the control plots were badly infected and that the mercuric chloride dust was not showing as good a control as Agrosan or Ceresan. The errors of the experiment were high, and show that the numbers of samples were too few; also the counts were few.

On June 2nd counts were again made and the analysis of variance calculated. The control plots were completely infected and infection had increased on all the treated plots. The mercuric chloride showed a definitely inferior control of the disease. The difference between the Ceresan and Agrosan plots did not reach significance. The counts were now more numerous and the errors of the experiment were reduced.

From June onwards infection increased, and by July it was im-

possible to find any plants on any of the plots which were not or had not been infected; therefore no further counts were taken. The yields of the plots had been regarded as the ultimate result, but wind and rain in July flattened the crop and all thoughts of obtaining reliable estimates of yields had to be abandoned. It can be stated that the yields of barley on the field in which the plots had been situated were two quarters per acre more than in the previous two years. Thus, although at harvest time every plant showed infection, the yield, apparently, had not been affected seriously. How far this may be due to the disease control in the early stages of growth is a point for further investigation, as the seed on the whole field had been dressed with Ceresan.

The foregoing account is intended to show the methods adopted for estimating the intensity of attack by a fungus disease on a cereal crop. Some of the difficulties encountered are indicated, and these were such as to render it impossible to obtain definite results.

In opening the discussion that followed the reading of these papers Prof. W. B. Brierley (University of Reading) said that:

In listening to the papers it seemed fairly clear that all the speakers had not been talking of the same thing and that the phrase "Measurement of Disease Intensity" was rather ambiguous. A plant was grown for a particular purpose or product and it seemed, therefore, that any measurement of disease intensity should bear relation to the purpose or product, and not to that portion of the plant which was only of accessory or temporary value. With annuals this seemed clear, but with perennials other considerations entered without obscuring the main distinction. If the amount of disease in the product increased *pari passu* with the amount of disease in the "plant," the latter could be used as a measure of the former, but often this relation did not hold. This led to a rather important distinction, *i.e.* the amount of disease in the field as compared with the amount of damage done to the product, a distinction expressed by the two terms "extensity" and "intensity." "Extensity" was largely a matter of distribution and rate of increase, whilst "intensity" was largely a matter of lethality.

Thus in human diseases, the common cold may be described as a disease of high extensity and low intensity, whereas pneumonia is a disease of low extensity and high intensity. The extensity of pneumonia is almost a measure of its intensity, but the extensity of the common cold bears no relation to its intensity. It seemed from what Mr Bescoby said that Net Blotch of barley might be a disease of high extensity and low intensity, since "although at harvest time every plant showed infection, the yield, apparently, had not been

affected seriously." Apple Scab, judged by Mr Marsh's experience, seemed to be a disease of moderate extensity and moderate intensity, and since the disease is measured directly on the product, the extensity is a measure of the intensity. Mr Beaumont's case of Potato Blight presented more difficulty, since he apparently presumed a direct relationship between disease intensity and the extensity, which was actually what he was measuring. All had probably known of heavily attacked crops in the field giving a comparatively clean crop of tubers, and, on the other hand, we may have been astonished to find the tubers from an apparently comparatively clean "plant" showing a considerable amount of rotting either on collection or later in store. That is, the extensity of blight in the potato haulms may, perhaps, not always bear direct relation to the intensity of disease in the tubers.

The smut diseases of cereals are mostly diseases of low extensity and high intensity, whereas rust diseases are mostly the reverse; or, if one takes mosaic diseases of tomatoes, the extensity of disease in a glasshouse stand is to be measured by the numbers of plants showing symptoms and the rate of spread to previously healthy plants, whereas the intensity of disease is to be measured by the percentage diminution or reduced grading in the fruit and in the last resort, perhaps, by money values. He did not want to stress unduly this distinction between "extensity" and "intensity" of disease, although it seemed to be rather fundamental in the problem of disease measurement.

All the speakers had emphasised the importance of accurate counting and exact measurement in dealing with this problem as against bulk or eye estimation, and he did not think that this point could be overstressed. Further, as Dr Clapham emphasised, it is essential where possible to obtain data of such a nature that the results can be analysed by statistical methods so that the accuracy and relative values of the experiments and observations can be gauged. The obtaining of such data usually implied a very careful lay-out of experimental or observational plots with considerable replication, and where several observers are involved it is imperative that they work by some common and very simple numerical scale and frequently check their observation by cross-comparison. He well knew how difficult it was for two observers familiar with a disease to obtain similar results when measuring distribution, spread or crop loss, even on one plot. Even with the utmost standardisation of observers, scales and material, there was often a significant variation in data obtained, since in the last resort most classifications involved a personal judgment. The complexity of the problem and the nature of the difficulties became apparent when attempts were made to compare disease intensity or extensity in, for example, one crop under

different cultural, manurial or climatic conditions, and more especially if one tried to get down to quantitative differences between small samples in the laboratory or glasshouse. With many diseases the degree of replication and the size and number of samples to be taken if statistically significant results were to be obtained are much larger than is usually realised, or than have usually been taken in the past.

Mr W. Buddin (Reading University) dealt with the subject from the point of view of one of the Advisory Officers of the Ministry of Agriculture. One of the duties of these officers is to send to the Ministry's Plant Pathological Laboratory at Harpenden, each month, a report on the occurrence, extent and intensity of the diseases of all crops grown in their Province. The information thus obtained, supplemented by reports from various other sources, forms the basis of a Monthly Summary prepared at Harpenden and circulated to all collaborators by the Ministry. As a comparatively prompt means of notifying such new and rare diseases as may be observed, this monthly summary is of definite value. It also serves in a broad way as a record of the epidemic intensity of some of the commoner diseases of crops from season to season, but as a statistically accurate record of the full extent and intensity of diseases over the whole country its value is necessarily limited.

One practical difficulty experienced by the Advisory Officer is that of applying accurate methods of measurement in the course of routine advisory work, especially in a large area like the Southern Province. Consideration of time and money, as well as the necessity of attending to research and daily enquiries at headquarters, prevent one from being in touch with more than a fraction of the crops in the Province. Moreover, for satisfactory data on disease intensity, information must be obtained regarding the variety of plant grown, date of sowing and type of manuring. It is therefore necessary to get into touch with the farmer himself and to obtain and retain his goodwill. The farmer is rightly suspicious of the too-narrow specialist, and in order to create the right atmosphere for the free exchange of information and the right spirit for the reception of advice, time must necessarily be spent discussing many matters in which the farmer is interested, other than plant diseases. Another factor to be considered is the English climate. The research worker can choose his time carefully for making observations on his plots; it is not so easy to obtain reliable measurements under the adviser's everyday conditions, for appointments must be made in advance and kept.

Other and more technical difficulties arise. In many cases it is a major research problem in itself to disentangle the effects on the crop of any particular specific disease, the intensity of which it is desired to measure, from the effects of the large number of other factors

concerned. In the field it is not a simple matter of the reaction of the host, under any particular seasonal conditions, to one parasite, but each crop may be attacked not only by all its fungus enemies, but by all its insect pests, and by many faults in feeding and in management at the same time. One might as well ask "What is a species?" as ask "What is wrong with strawberries?" In both cases such special investigation as has been carried out has got us little nearer any practically helpful truth than shrewd, and experienced, observers were able to approach at the start.

Barley may be taken as an example of a cereal crop. Whatever may be the merits of Mr Bescoby's method for measuring the extent of attack by *Helminthosporium teres*, who can estimate hurriedly how many pounds a farmer has lost through this fungus alone, when the crop may be full of *Helminthosporium gramineum*, Gout Fly may be prevalent, cultivation bad after a sheepfold, sowing done rather too late, and patches of the field too acid for successful growth of barley?

If one turns to wheat, another point is brought out, namely, that different phases of the same disease are important and complicate the situation. At one time all the Foot-Rot type of trouble was attributed to *Ophiobolus graminis*. Emphasis was later thrown on the Foot Rots due to *Helminthosporium*, and more recently it has been shown that several species of *Fusarium* may also play a part. The task may be simplified for the busy adviser by asking him to estimate the financial loss to the farmer caused by the Foot-Rot group of fungi. Even then, not only has he to take into account the "Take All" phase of the disease when the tillers fail to ear, the "White Heads" phase with its incompletely filled ears, and the plants which have been merely weakened by the attack, so that they produce badly filled grains, but he has to distinguish plants laid through excessive doses of available nitrogen, or laid by the weather because the variety is a weak-strawed one; moreover, how many farmers delight to see a pathologist making his way, traverse after traverse, through a field of waving, golden grain?

On the other hand, if the measurement of disease intensity is made a task in itself, and not merely an incidental to other work, there is no doubt about the usefulness of accurate measurement of the amount of attack in special cases and for specific research purposes. With some diseases the amount of loss can be estimated only approximately, and after repeated visits to the same field, but with a disease such as bunt in wheat there is little need to examine the crop until harvest time, and no technical knowledge is required to count the healthy and bunted ears. An accurate measure of the amount of bunt in the crop can readily be obtained and, in point of fact, a useful co-operative experiment on this disease was recently carried through successfully in this country (see *Journ. Min. Agric.* XXXVII (1930), 429).

It will not always be so easy to ensure that the particular disease comes along on the experimental plots as does bunt of wheat, but there are doubtless many other diseases on which similar satisfactory co-operative research could be carried out, involving the accurate measurement of disease intensity.

Finally, methods of measuring disease intensity may be looked upon as a form of training, and as a means of gaining field experience.

The working out, and carrying out, of methods for the accurate measurement of disease intensity, not only in pots and plots around research stations, but in the fields of ordinary growers, with the caustic, pointed comments of the practical grower to assist him, is one of the best ways of getting the modern worker into actual contact with the growing crops, and helping him to realise the complexity of the problems of the commercial grower which await solution. A warning may be added. If the ultra-conscientious worker is set to collect statistical data he will, unless he is very well supervised, soon amass notebooks of meaningless figures, and be quite unable to see the wood for the trees, and produce no practical conclusions at all. On the other hand, those who draw conclusions only too readily should keep above their desks the following quotation from a recent report of the Development Commission: "The scientific worker of the new type was different. His methods were exact: his facts, so far as they went, must be accepted, but his conclusions were apt to be wider than his experience." The reference was to the agricultural adviser of twenty years ago, when the Development Fund was started, but what applied to the lecturer in agricultural chemistry of those days, is still apt to be applicable to the biological research worker.

To avoid these dangers, work on methods of measuring disease intensity needs to be combined with a practice of sending workers to live in the districts producing the particular crops on which they are carrying out investigations.

Mr M. H. Moore (East Malling Research Station) explained how the results of his spraying trials for scab control on Fertility pears in 1931 and 1932 (see *East Malling Res. Sta. Ann. Rep. for* 1932 (1933), 99, and *Journ. Min. Agric.* XL (1933), 111) had demonstrated that interpretations of spray efficiency varied according to the method of evaluating the intensity of scab infection on the fruits. Bordeaux mixture gave similar control to lime-sulphur solution when the total area of scab spots was assessed by grading, but when only the number of scabbed fruits in relation to clean ones was considered, Bordeaux was significantly superior to lime-sulphur. Trees sprayed with Bordeaux mixture showed a greater proportion of clean fruits than those treated with lime-sulphur solution and hence, in spite of heavier infection on the fruits that were scabbed, Bordeaux mixture was, in respect of scab control, the more commercially valuable spray.

ENGLISH INDEX TO PERSOON'S SYNOPSIS

By J. RAMSBOTTOM

When preparing an account of the history of Essex Mycology I came across *An Introduction to the knowledge of Fungusses* by Benjamin Meggott Forster (1820), a small book of twenty pages, but of unusual merit. The list of references to this work mentions "Persoon. *Synopsis Methodica Fungorum Gottingae.* By C. H. Persoon, 1801. (Index Botanicus, containing the names of all the species in Persoon's Synopsis, was reprinted in London, 1819: and is sold by T. and G. Underwood, price one shilling.") The fact that the firm of T. and G. Underwood was also given on the title-page of B. M. Forster's book suggested that he might be the compiler of the English edition of the Index.

This is not so however. The Index was compiled by D. G. H. L. (Georg Heinrich Luenemann) and published at Göttingen in 1808. (Persoon's *Synopsis* has only an index to genera.)

The English edition was published in 1819. It is a well printed 12mo. of thirty-two pages. The title-page reads:

"Index Botanicus | sistens omnes | Fungorum Species | in D. C. H. Persoonii | Synopsi Methodica | FUNGORUM | enumeratas | una cum varietatibus et synonymis, | confectus | a | D. G. H. L. | Gottingae | apud Henricum Dieterich | 1808 | London: Reprinted | For T. and G. Underwood, Fleet Street; Anderson, | West Smithfield; and Adam Black, Edinburgh | 1819."

On the inside of the cover there is added:

"OBSERVATIONES CIRCA FUNGOS FACIENDAE.

"1. An varietates specierum a soli differentia oriuntur? aut qua de causa?

"2. Quae tempestates fungorum luxuriae magis favent? viz.
Tota aestas pluviosa;
Aestas pluviosa et auctumnus aridus, aut *Aestas arida sequente auctumno pluvioso*?*

"3. An color ejusdem speciei in diversis regionibus variatur. Statuendum est quae nomina, aliis synonymis (diversis catalogis) respondent; ut *Sowerbii, Persoonii, Schaeffer,* &c.—ED."

* Auctumnus 1818 post aestatem aridam praecipue fungorum speciebus abundabat. Vide "Observations on the abundance of fungi at Hartfield in Sussex," in *Philosophical Magazine* for Oct. 1818.—T.F.

At the end of the list is a short N.B. "The Editor will be obliged for any communications respecting *fungi*, addressed to him under cover, to Mr. Underwood, Fleet Street."

The reference to Hartfield and the initials T. F. show that the editor was not B. M. Forster but his even more versatile nephew, Thomas Ignace Marie Forster, the son of Thomas Furley Forster. Among other matters he was greatly interested in the "atmosphere." According to his *Recueil de ma Vie, mes Ouvrages et mes Pensées* he went to live at Hartwell, near Hartfield, Sussex, in May, 1818.

The paper he refers to is "On the seasons which are most favourable to the growth of Fungi, etc., with an account of some remarkable growth this present Year" which appears as a letter signed "T. F., Hartfield" in Tilloch's *The Philosophical Magazine*, LII (1818), 299–300.

In view of the conditions of the present year parts of the letter appear to be worth quoting:

"It has generally been believed that wet seasons were favourable to the growth of mushrooms and of *fungi*; in general, the result of the present year, however, contradicts this notion. For after one of the hottest and driest summers which has happened within the memory of the oldest man in this village, the whole of this tribe of plants have been more abundant than for many years past; and some of them have exhibited an extraordinary luxuriance of growth.

"The common mushroom, *Agaricus campestris*, has been everywhere particularly abundant, and of large size: they began to appear in this neighbourhood just after the few days of rain early in September, and are still very numerous in all the open meadows and low lands hereabouts."

The other species mentioned are: *Agaricus integer* [*Russula* spp.], *A. floccosus* [*Pholiota squarrosa*], *A. denticulatus* [*Mycena pelianthina*], *A. glutinosus* [*Gomphidius*], *A. stercorarius* [*Coprinus* sp.], *A. fascicularis* [*Hypholoma*], *Boletus bovinus*, *A. plicatilis* [*Coprinus*]; "the genus *Peziza* has been rather scarce this year.—I am induced to think that the most fruitful sort of season in fungi is one where a hot and dry summer is succeeded by a moderately wet autumn; as by looking back in my Journals I find this frequently to have been the case, while the wholly wet summers and autumns have been less productive."